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FARMERS' BULLETINS
Nos. 901–925,

WITH CONTENTS AND INDEX.

PREPARED UNDER THE SUPERVISION OF
EDWY B. REID,
CHIEF, DIVISION OF PUBLICATIONS.

30491/2

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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EVERBEARING STRAWBERRIES

GEORGE M. DARROW

Scientific Assistant, Office of Horticultural and Pomological Investigations

FARMERS' BULLETIN 901

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C. November, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

441.99.42

STRAWBERRIES may now be had throughout the summer and autumn months in the northern United States. Plants of the everbearing sorts may be set in the spring and a crop secured in the summer and autumn of the same year. The habits of these varieties have led to the development of cultural practices differing in special details from those followed in the production of standard sorts. Such practices are described in this bulletin, giving directions for raising the everbearing sorts.

The plants are very hardy, their foliage is very resistant to disease, and under favorable conditions they continue to produce berries until hard frosts occur. These characteristics make them especially suitable for the home garden.

EVERBEARING STRAWBERRIES.

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DESIRABILITY OF EVERBEARING SORTS OF STRAWBERRIES.

MUCH INTEREST has developed recently in certain varieties of strawberries which bear fruit after the usual season. These so-called "everbearing" sorts produce fruit in early summer and under favorable conditions continue to do so until autumn. The term "everbearing" is not entirely satisfactory, but it has been in common use for several years and therefore is used in this bulletin. Heretofore the everbearing varieties have been grown chiefly by amateurs and by commercial growers who have tested them in comparison with ordinary sorts; however, a sufficient number of trials

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FIG. 1.—A field of Progressive strawberries on the place where the variety originated at Conrad, Iowa. (Photographed Sept. 22, 1916.)

of these varieties has been made to indicate their real value for home use and for market in certain sections of the country.

The two leading varieties of this type of strawberry, the Progressive and the Superb, are notable not only because they produce fruit from the time of the usual crop until late summer or autumn, but also because they are exceptionally resistant to leaf-spot diseases. They are also very hardy. The Progressive has been found to withstand the winters of the Middle West better than any other variety except the Dunlap, one of its parents. The Superb, also, is hardier than most varieties of strawberries. Another remarkable characteristic of these varieties is that if their blooms are killed by frost they soon flower again. Therefore, in sections subject to late spring frosts, which often destroy the crop, these varieties are particularly valuable.

The markedly different behavior of these varieties in the field has led to the development of cultural practices differing in special details from those followed in the production of standard sorts. For this reason the information herein given concerning the origin and characteristics of these varieties has been prepared, and directions for their culture in so far as these methods differ from those used in growing the varieties which fruit only in the early summer are also included.

ORIGIN.

The Alpine strawberry, which is indigenous to many parts of the European Alps, has the habit of fruiting continuously from early summer to autumn. The fruit of the Alpine strawberry is small, and the horticultural varieties under cultivation are used only to extend the strawberry season. Although the Alpine berry was introduced into cultivation at least 150 years ago, it has never become of commercial importance.

During the latter part of the nineteenth century the Alpine strawberry was hybridized with large-fruited varieties which bear crops only in early summer, and, as a result, many "perpetual-fruiting," "autumn-fruiting," or "four-season" varieties, as they are called, bearing good-sized fruit, are grown in Europe. Among the best of these are the St. Antoine de Padoñe, St. Fiacre, St. Joseph, Merveille de France, and Louis Gautier, none of which has proved desirable in North America.

In this country most of the everbearing strawberries have had a very different origin. On September 28, 1898, Mr. Samuel Cooper, of western New York, while examining his field of strawberries, noted a plant with several runner plants attached, all of which were bearing blossoms and fruit in all stages of development. The plants among which these were found were of the Bismarck variety, which is reported to be a cross between the Van Deman and the Bubach.

Mr. Cooper set apart these plants which were bearing fruit in the autumn and named the variety the Pan American.

From the Pan American have been developed the leading everbearing varieties. Mr. Cooper has introduced the Autumn, Productive, Superb, Peerless, Onward, Forward, and Advance—all descendants of the Pan American. Of the varieties which have been widely tested to date, the Superb is the most valuable. Figure 2 shows part of a field of this variety on the place where it originated. The value of the Advance, Forward, Onward, and Peerless varieties has not been determined, although the Peerless seems to possess characteristics which may make it more desirable than the Superb.

Mr. Harlow Rockhill, of Iowa, has also produced many everbearing varieties, using in his work the Louis Gautier, one of the European everbearers, the Pan American, and many of the standard varieties which under normal conditions fruit only in early summer. The Americus and the Francis are the result of a cross between the Louis Gautier and the Pan American. Mr. Rockhill's best-known variety is the Progressive, a cross between the Dunlap and the Pan American. Figure 1 shows part of a field of the Progressive variety on the place where it originated. Other varieties originated by Mr. Rockhill are

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FIG. 2.—A field of strawberries of the Superb variety set in April, 1915, and grown under the hill system on the place of the originator of the variety at Delevan, N. Y. A crop was picked in the autumn of that year, and another crop was picked in June, 1916. (Photographed June 28, 1916.)

the Iowa and the Standpat, both of which are results of crosses between the Pan American and the Dunlap.

Several other individuals, including workers at the Minnesota Agricultural Experiment Station, have originated new varieties which fruit during the summer and autumn months. These are being tested at the present time to determine their value.

CHARACTERISTICS AND ADAPTATION.

The everbearers are easily confused with other sorts unless certain facts are held clearly in mind. Ordinary early summer varieties may have a long season of fruiting under certain conditions; thus, in central Florida the Missionary variety begins to ripen soon after December 1 and continues to produce berries until after May 1. In the same section the Klondike and some others begin to bear early in February and continue in season with the Missionary. Farther north, however, these varieties produce an early-summer crop only, and that at the regular season. Conditions somewhat similar to those in Florida prevail in some parts of southern Texas.

In southern California ordinary varieties, such as the Brandywine and Excelsior, bear almost continuously under irrigation from early in March until late autumn. The Brandywine produces one crop, and, after a short rest period, a second crop, and later a third crop. The Excelsior and Melinda (*Molinda*), however, bear almost continuously from April to November in that section. Farther north on the Pacific coast the length of the fruiting season of all varieties is shorter, and in Oregon, Washington, and Idaho usually one crop only is harvested. Even in those States certain varieties when given a rest period after producing the early-summer crop and then irrigated will produce a second crop in the autumn.

In the eastern United States there is no definitely dry period, so that the plants do not have a real rest or dormant period after the harvest season. Under these conditions a second crop is seldom secured from the ordinary varieties. Occasionally, however, a prolonged drought followed by rains may furnish conditions favorable for a second crop; thus, in 1914 a grower at Harriman, Tenn., harvested a second crop of the Wallace (*3–W*) variety. In Kentucky the Early Hathaway (*Texas*) exhibits a slight tendency to bear in late summer whether the season has been dry or not. In Wisconsin, the Warfield occasionally has produced good fruit in the autumn, and the Dunlap at various times has produced a small second crop.

The everbearing sorts, however, differ from all of the above varieties in bearing fruit in the northern United States under favorable conditions continuously from the season of the ordinary varieties until frost. The quantity of fruit secured during this period varies

with climatic conditions, with the cultivation, and with the variety. The amount of fruit borne by the plants at the different periods of the year also varies.

Plants of the everbearing type which have been set for a year bear a fair crop at the time the usual crop is borne. For the period immediately after this early-summer crop, the amount of fruit secured is small. In August, September, and October it becomes larger, and, under favorable conditions, the late-summer and autumn crop from certain varieties may equal or exceed the early-summer crop. Thus, instead of a constant supply throughout the season, there is a distinct early-summer crop, then a period of comparative rest when little fruit is produced, followed by a long period when a fairly uniform amount of fruit is borne.

Weather conditions play an important part in the amount of fruit produced during the summer and autumn. Only when the moisture supply and other climatic conditions are favorable can the yield be constant. For this reason the results obtained from the varieties of this type of strawberry have varied greatly in the different sections of the country and in different years. If a long drought occurs while the plants are fruiting, the berries become small and the plants finally cease to bear. Therefore, they are not well adapted to sections having long droughts, except when irrigation can be supplied.

Other climatic conditions also influence the yield of everbearing strawberries. As all the varieties of this type have originated in northern States, where the summer heat is not great and where the rainfall is comparatively uniform throughout the year, they are best adapted to such conditions. In southern regions, where the Klondike and Missionary varieties are grown, the everbearing varieties have not yet proved well adapted. The Dunlap is grown commercially north of the regions where the Klondike and Missionary succeed, and it is in regions where the Dunlap succeeds that the everbearers are known to be adapted. These regions extend south to the northern parts of Virginia, Kentucky, Arkansas, and Kansas. South of these limits there are probably points where they may be grown with some degree of success, but they are not definitely known to succeed there at the present time.

In Oregon and Washington, the Superb, Americus, and Progressive have been grown successfully. In Idaho, where late spring frosts occur, the Superb has proved especially valuable, for when frosts have killed the bloom on varieties which fruit only in early summer, these will not ordinarily send out new flower stems until the following year, while the Superb will send out new flower and fruit stems immediately and produce a full crop.

Few reports of the value of these varieties in California are available, but nothing seems to be gained by planting them, as most of the ordinary sorts fruit there throughout the summer.

SOILS.

Growers of the Progressive and Americus varieties agree that a more fertile soil is required for them than for the ordinary sorts. The berries of both of these varieties are rather small, and a fertile soil is needed to increase their size. Another reason for their need of a fertile soil is that all the everbearers require a larger supply of moisture than do the sorts which produce only plants after the early-summer crop of fruit. A slight deficiency in the moisture supply seriously affects the size and quality of the berries, but does not noticeably affect plants producing runners only. A soil classed as very fertile contains a large amount of humus, and one important effect of a large humus supply is to increase the moisture-holding capacity of the soil. Any soil, therefore, containing large amounts of humus, or to which humus has been added by turning under green-manure crops or by the application of stable manure, will be better able to supply sufficient moisture, and one especially well supplied with humus should be selected.

The Superb and other varieties having similar characteristics, however, should be grown on a soil which is rather low in nitrogen. (For descriptions, see the section on "Varieties," pages 17 to 19.) In soils that are too rich, varieties of the Superb type bear a good crop in the early summer and then make a rank growth of leaves and runners throughout the rest of the growing season, just as do the ordinary early-summer sorts. Under such conditions, little fruit will be secured in the summer and autumn. For the best results, these varieties should be grown on a soil in which the supply of nitrogen is somewhat deficient for ordinary vegetable and fruit crops. The soil, however, should furnish an ample supply of moisture throughout the season, or water should be supplied by irrigation. This peculiar soil requirement of the Superb—that is, a soil somewhat lacking in nitrogen, but furnishing a good supply of moisture—is one reason why it has not been as popular in some sections of the United States as the Progressive. On the other hand, the irrigated sections of the Northwest are especially well adapted to the Superb, as many of the soil types are low in nitrogen.

FERTILIZERS.

Since the Superb and other varieties of its type should be grown on soil somewhat low in nitrogen, fertilizers containing nitrogen should not be applied ordinarily to plantations of these varieties. If

fertilizer is applied, it should contain only phosphoric acid and potash.

The Progressive and Americus need fertile soils, and stable manure usually can be applied with profit to plantations of these varieties. As much as 20 tons per acre may be used with good results, and some growers use even larger quantities. It will be found most satisfactory to apply the stable manure to the land the year previous to that in which the strawberries are set. Weed seeds in the stable manure can then germinate and be destroyed, while if the stable manure is applied directly to the plantation the cost of eradicating the weeds will often be considerable. Commercial fertilizers are rarely used with these varieties.

TIME OF PLANTING.

Plants of the everbearing type should be set at the same time as those of other varieties. The amount of fruit secured the first year, however, depends to some extent upon the time of setting. If the plants are set as soon as the ground is in condition in the spring, a larger crop will be secured than if they are set later. The plants also have opportunity to become established and to develop better root systems before beginning to fruit. If they are set rather late in the season, they show less tendency to make runners than when set very early.

PLANTING SYSTEMS.

The everbearers are grown under the matted-row and the hill systems of culture, and growers have been very successful with each. Under the hill system only the plants originally set are kept for fruiting, no runner plants being allowed to develop. Under the matted-row system, however, runner plants are allowed to root and form beds varying in width from a few inches to 3 or 4 feet. Larger crops of the everbearers probably can be secured the first year under the hill system than under the matted-row system. The cost of raising them, however, will be greater, as a much larger number of plants are set than under the matted-row system.

One of the most important factors in determining which system is to be used is the fruiting habit of the variety selected. Thus, the Americus, Francis, Standpat, and Progressive varieties fruit on the runner plants almost as soon as the runners take root, while the runner plants of other varieties bear very little fruit or none at all before the following year. During the first year, from a certain number of plants to start with, the varieties mentioned above usually will produce larger crops if they are allowed to form runner plants freely than if kept in hills. Figure 3 shows a plant set in the early spring which has runner plants with bloom and young fruit. The

P20328HP

FIG. 3.—A strawberry plant at Osage, Iowa, set in the spring, having runner plants in bloom in midsummer. (Photographed July 13, 1916.)

Superb, Peerless, Autumn, and some others bear more during the first year if not allowed to make runners than if runner plants are allowed to form.

The plant-making ability of a variety, however, should be considered before deciding upon the system to be used. The Americus, Autumn, Francis, Pan American, Productive, and Standpat do not make runner plants as freely as the Progressive, Superb, and certain others, and thus are better adapted to hill culture than the last-named sorts.

In ordinary practice, therefore, the Progressive should be grown under the matted-row system and the other varieties under the hill system, except, however, in sections where the Superb and others of its type are kept for a spring crop.

DISTANCE OF PLANTING.

Under the matted-row system the plants should be set at the same distance as ordinary varieties, such as the Dunlap, Gandy, and Glen Mary—that is, from 18 to 36 inches apart in rows which are 3½ to 4 feet apart. When set 2 by 4 feet, 5,445 plants will be required to plant an acre. About 50 plants, the number needed to set a square rod, should supply a small family with berries throughout the season.

Under the hill system the plants should be set the same distance as are the ordinary varieties. If set 18 inches apart in rows 3 feet apart, 9,680 plants per acre will be needed; if 18 inches apart in

double rows in which the single rows are 18 inches apart and the double rows 4 feet from center to center, 14,520 plants per acre will be required. Figure 2 shows a field of the Superb variety planted under the hill system in single rows; figure 4 shows a field of the Progressive variety set under the same system but planted in double rows.

REMOVING BLOSSOMS AND RUNNERS.

Flower stems begin to appear soon after the plants are set. Unless the plants are well established, these flower stems are a severe drain on the vigor of the plants, while very little good fruit will be secured from them. For this reason all flower stems which appear before the plant is thoroughly established should ordinarily be removed. If, however, growing conditions are favorable, the plants may become established very quickly and the removal of the flower stems will not be necessary. Figure 5 shows a young plant so thoroughly established that the flower stem need not be removed. When growing conditions are not favorable, the flower stems should be kept picked off until into July. Berries begin to ripen about a month after the flower stems are allowed to develop fruit, and continue to ripen until freezing weather occurs.

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FIG. 4.—A field of Progressive strawberries grown in double rows under the hill system at St. Joseph, Mo. All runners are removed as they appear. (Photographed July 15, 1916.)

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FIG. 5.—A strawberry plant of the Progressive variety set in the spring at Bridgman, Mich., which at the end of June shows a runner and a flower stem and is so thoroughly established that the flower stem need not be removed. (Photographed June 30, 1916.)

The removal of the flower stems does not cause the everbearers to revert to the early-summer fruiting type. The plants will make a more vigorous growth of leaves and runners when the flower stems are removed, sometimes making less fruit than if the stems had been left on. This, however, does not mean that they are reverting, but that for a time they are making plant growth at the expense of fruit production.

The following spring, if the plantation is continued, a fair to large crop of berries, depending on the variety, may be expected at the usual fruiting season, and after a period of two weeks to a month, in which comparatively little fruit is picked, the plants will begin to bear again. It will prove costly to pick off the flower stems during the spring of the second year, but where it is desired to secure as much fruit as possible after the ordinary varieties are gone the flower stems should be removed until about the time the ordinary varieties begin to ripen. If berries are then allowed to develop, they will be ready to pick in about four weeks.

In practice, growers using the hill system of culture commonly remove the flower stems the first year only, and those using the matted-row system rarely remove them, considering the expense too great.

Those growing the everbearers under the hill system also cut off all runners as they appear. This conserves the vigor of the plants, making them larger and more productive than those sending out runner plants. Some growers use a knife with which to cut the runners; others a hoe. Some of the runners may be removed at the time of each cultivation by attaching a runner cutter to the cultivator. When this is done it will be necessary to remove the remainder with a hoe.

TILLAGE.

Tillage should be very thorough, even more thorough than for the varieties that fruit in early summer, and unless a mulch is used should be continued from early spring until late autumn. In periods of drought, the cultivator should be used as often as once a week, for without an adequate and constant moisture supply a large crop of fruit can not be matured. Tillage should be shallow, especially near the plants, so as not to injure the root system or loosen the plants in the ground. A cultivator with many small teeth is best adapted to such use. The outer teeth of the cultivator which run next to the rows should be shortened so that they will not disturb the roots of the plants.

MULCHING.

When planted on some types of soil the berries are likely to become gritty if the tillage is continued through the fruiting season. To keep them clean, many growers use a mulch of grass, swamp hay, or straw, applying it at the beginning of the fruiting season. To fields grown under the hill system a heavy mulch may be applied. It will assist in keeping down weeds, in preventing the runners from rooting, and in conserving moisture. If a mulch is used on fields grown under the matted-row system it should be light, as a heavy mulch would prevent many of the runners from taking root.

DURATION OF A PLANTATION.

Those who grow the Progressive variety usually consider it best to set the plants early in the spring, pick a crop of fruit through the summer and autumn, and then discontinue the plantation, thus making the strawberry an annual crop from which the fruit is secured entirely in months outside the usual strawberry season. Those who wish to secure some fruit for the home table may leave the plantation until after the fruiting season of the following summer before plowing it up.

The berries produced on the 1-year-old plants, however, will be small compared with the common sorts, and will be smaller than the fruit of the Progressive variety secured in the summer and autumn of the first year. Figure 4 shows a field of the Progressive strawberry several years old. Fruit from this was comparatively small, although very large quantities of stable manure had been applied annually and the bed irrigated at frequent intervals.

The Superb and varieties similar to it under favorable conditions bear a fair crop of good-sized berries in the summer and autumn of the year they are set. At the ordinary season the following spring they yield a large crop of fair-sized berries, which under favorable

conditions will be as large as those produced by the common sorts. For this reason, varieties of the Superb type are much better adapted for use where the same plantation is to be maintained for several years than are varieties of the Progressive type. Figure 2 shows a field of Superb strawberries that had produced a crop in the summer and autumn of 1915 and another crop in June, 1916. This plantation was also allowed to fruit during the summer and autumn of 1916.

The duration of the plantation, therefore, will depend largely upon the variety used, but to some extent also upon the planting system and the climatic conditions in the section in which the plantation is made. If the Progressive variety and others of its type are used, it will ordinarily be best to set a new plantation each spring. If the Superb variety or others of its type are used, the plantation should be maintained according to the practice usually followed with varieties fruiting only in the early summer.

HARVESTING.

The harvesting of everbearing strawberries is similar to that of ordinary sorts, although more costly, as the fruit ripens through a long period and not as much is secured at one picking. The berries of some varieties of everbearers are of excellent quality, and, as they ripen in warm weather out of the usual season and bring a good price, should be carefully picked and packed in attractive packages. In the warmer part of the summer the berries will be soft and very difficult to market in good condition. Particular attention to careful handling will therefore be necessary.

In late autumn when the weather is cool the berries lose the high quality which they possess earlier in the season. Some berries may ripen even after hard frost, but such berries will not be of very high quality. The varieties differ greatly, however, in this respect, the Progressive remaining good in quality until cold weather, while the Superb has little flavor after cool weather begins.

YIELDS.

The yields secured will vary with the climate, the soil, the variety, and the attention given to culture. Up to the present time, everbearers have been grown chiefly by those using intensive methods of culture. Such methods increase the yields. The available records of yields are from the fields of those who not only use intensive methods but who have been successful, and the records, therefore, do not represent average yields. These records, however, show that throughout the northern United States, when set in early spring, the Progressive plants will begin bearing in July and will continue until hard frost occurs, provided moisture and other conditions are favor-

able. Under the best conditions, as much fruit can be secured in the summer and autumn of the first year as from ordinary varieties in early summer. To secure such results, however, water must be supplied in periods of drought and other conditions must be favorable.

In sections east of the Rocky Mountains the Superb variety and others of its type will not give as high yields as the Progressive and are not generally as desirable for the summer and autumn crop. When all conditions are favorable, however, over a thousand quarts per acre may be secured during this period. In the irrigated sections of Idaho, Oregon, and Washington, the yields in late summer and in autumn will be much larger, as the conditions in those States seem to be more favorable for this variety. The early-summer crop of the Superb ordinarily will be much larger and the berries much better than those of the Progressive; in fact, some growers have found the early-summer crop of the Superb as large as that of many of the common sorts.

VARIETIES.

The varieties of everbearing strawberries in the trade at present are Advance, Americus, Autumn, Forward, Francis, Iowa, Onward, Pan American, Peerless, Productive, Progressive, Standpat, and Superb. In addition, a variety known as the Minnesota No. 1017, distributed by the Minnesota State Horticultural Society and the Minnesota Agricultural Experiment Station, has been introduced.

Only two of the varieties introduced, the Progressive and the Superb, have been widely grown as yet. The Americus is grown to a slight extent and the others very little. The Minnesota No. 1017 has been widely tested in Minnesota and is grown to a slight extent in surrounding States.

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FIG. 6.—Strawberry plants of the Minnesota No. 1017 variety at Excelsior, Minn. The plant at the left, producing much fruit, has no runner plants; the one at the right is producing a small crop of fruit and many runner plants. (Photographed Sept. 26, 1916.)

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FIG. 7.—Strawberry plants of the Minnesota No. 1017 variety at Excelsior, Minn. At the left in the foreground is a plant bearing a large crop of fruit but no runners; at the right in the foreground is a plant bearing no fruit and making no runners; the plants in the background have made a few runners. (Photographed Sept. 26, 1916.)

These varieties have been selected by strawberry breeders from large numbers of seedling plants as being best adapted to commercial purposes. When plants are raised from seed, some show no sign of bearing fruit at any but the ordinary season; other plants begin to fruit within three months from the time the seed germinates and fruit so heavily that no new plants are produced; while still others show sufficient vigor to produce both fruit and young plants. The varieties introduced likewise show great variation in their fruiting and plant-making habits. Moreover, the balance between the fruiting and plant-producing habits of many of the varieties is so even that frequently some plants fruit so heavily that no runner plants are made; other plants produce both fruit and runners; while still others may produce no fruit. This is especially noticeable if the plants are set late. Figure 6 show a plant bearing a heavy crop of fruit, but no runners; and another plant producing some fruit and many new plants. Figure 7 shows two plants which have made no runner plants, one having a heavy crop of fruit, the other none. The plants in these illustrations were set rather late, and their difference in behavior is probably due somewhat to this cause.

Many other varieties are in the hands of breeders and will be introduced as soon as a sufficient stock has been secured. Some of them have been originated by men who have had long experience in strawberry growing and no doubt will be of great value. In addition, these breeders have many thousands of seedling plants of everbearers, from which many desirable varieties may be expected to appear. To replace present varieties, the seedlings should possess a high degree of resistance to leaf-spot diseases, exceptional vigor and hardiness,

and good quality, in addition to producing fruit in the summer and autumn.

Brief characteristics of the varieties in the trade at present are given here. Most of them have been placed in two classes: (1) Those with fruiting habits somewhat similar to the Superb and (2) those with habits more like the Progressive. Those originated by Samuel Cooper are more like the Superb, while those originated by Harlow Rockhill have fruiting habits resembling the Progressive or Americus. Except when otherwise noted, the varieties are perfect flowered and may be set alone.

Advance.—Very similar to the Superb and the Peerless. It is not recommended for replacing either of these varieties, although it is perhaps somewhat firmer in flesh than either of them.

Americus.—Plants vigorous, deep rooted, runners forming fewer plants than many varieties; foliage rather sparse, exposing the berries somewhat; fruiting stems long; berries medium to large, firm, light red, often having a green tip when the body of the berry is fully ripe; dessert quality the best of any perpetual.

This variety is a cross between the Pan American and the Louis Gautier, originated in 1905 by Harlow Rockhill, of Iowa, and introduced in 1912. It is better adapted to heavy soil types than to sandy loams. Runner plants often begin to bear as soon as they start to root. The June crop is sometimes heavy and very good, and under favorable conditions the same plants will bear constantly from June until November. The variety is grown very little at the present time, but, because of its excellent quality, is liked by some growers, especially for hill culture in home gardens or for local markets.

Autumn (flowers imperfect).—Originated by Mr. Samuel Cooper, of New York, in 1902 from seed of the Pan American and introduced in 1906. It has been replaced by better varieties and is grown very little at the present time.

Forward.—Very similar to the Superb and the Peerless, but not recommended for replacing them.

Francis.—Plants not as vigorous as those of Americus, the runners forming fewer new plants; fruiting stems long; berries large, often irregular in shape, attractive; dessert quality very good, but not equal to that of Americus, Progressive, or Superb.

This variety was originated by Harlow Rockhill in 1905 at the same time as the Americus and as a result of the same cross. It is best adapted to light, sandy soils. The runner plants begin to fruit as soon as they start to root. The variety, however, is grown very little at the present time, although at one point in northern Michigan it is considered desirable.

Iowa.—Plants rather vigorous, sometimes making a good number of runner plants and sometimes very few; foliage abundant, protecting the flowers from frosts and rains; fruit stems short; berries medium in size, globose, fairly firm, dessert quality fair, but not as good as Americus, Progressive, or Superb.

The variety is a cross between the Dunlap and the Pan American, originated by Harlow Rockhill and introduced in 1911. The runner plants do not bear much the first year, and it is inferior to the Progressive as a commercial berry. It is grown very little at present.

Onward.—Very similar to the Superb and the Peerless, but it is not recommended for replacing either of these varieties.

Pan American.—Plants vigorous, but they do not make many new runners; foliage susceptible to mildew; fruit stems short and well protected by the leaves from rain and frost; berries medium in size, dessert quality fair.

The first plants of this variety were found by Samuel Cooper, of New York, in a field of Bismarck, and it is supposed to be a sport of that variety. Only a small crop is borne in the autumn. It is grown very little at present and is known chiefly as a parent of most of the everbearers.

Peerless.—Very similar to the Superb, and although recently introduced is considered slightly superior to it in being larger in size, better in dessert quality, and more productive. It is adapted to conditions similar to those under which the Superb succeeds and should replace that variety in many sections.

Productive (flowers imperfect).—The result of a cross between the Pan American and the Autumn, originated by Mr. Cooper. As the berries are of poor quality and the foliage is very susceptible to leaf-spot, it is not to be recommended.

Progressive (*Nevastop*).—A cross between the Dunlap and the Pan American made in 1908 by Harlow Rockhill, of Iowa, who first sent it out for trial in 1911. It is described by him as follows:

> The plant is medium sized, closely resembling the Dunlap; foliage strong and healthy, has a good root system, and makes about as many plants as Dunlap. Spring-set plants fruit the same year as set out. New plants generally fruit in a short time after taking root. Blossoms are strongly staminate and very resistant to cold. Blossoms and fruit are well protected by foliage. Fruit is of good medium size with slight neck. Color deep red inside and out, quite firm, quality rich and sweet.

This is a good characterization of the Progressive. The plants are the most vigorous of all of the everbearers now in the trade, and are, so far as observed, the hardiest variety of strawberry now grown in this country, enduring the extreme climate of the upper Mississippi Valley remarkably well. The foliage is very resistant to leaf-spot diseases. Both the plant and fruit closely resemble the Dunlap. The spring crop begins to ripen very early—8 to 10 days earlier than Dunlap, and usually earlier than Excelsior, Michel, and other early sorts. It is adapted to sections where the Dunlap succeeds and should be planted on fertile soils.

Standpat.—Originated by Harlow Rockhill in 1906 and introduced in 1914. It is lighter colored and larger than the Progressive, is too soft for shipping, and makes new plants slowly. It is not recommended for general planting at the present time.

Superb.—Plants vigorous, runners long and do not form a thick mat of plants except on moist rich soil; foliage very resistant to leaf-spot diseases; berries medium to large, globose to globose conic, fairly firm, color variable, often light red until very ripe, when they turn dark; mild subacid; dessert quality good in the summer, but lacking in the autumn.

The Superb is a cross between the Sherman (a seedling of the Pan American) and a seedling resulting from a cross between the Autumn and Cooper. It was originated in 1908 by Samuel Cooper and introduced in 1911. It is especially adapted to poor soils provided there is plenty of moisture. Runner plants rarely bear fruit the first year. The berries resemble the Chesapeake in appearance. The first crop in parts of Michigan and in certain other States is reported equal to that of some of the ordinary varieties. It is grown more than any other perpetual except the Progressive, but probably should be replaced by the Peerless in most sections.

Minnesota No. 1017.—In Minnesota, as compared with the Progressive, this variety is more vigorous, not as good a runner maker, and fully as productive; the foliage is much more susceptible to leaf-spot diseases; the berries are larger, more globular, fully as firm, slightly darker red in color, and of as good dessert quality.

The variety is a cross between the Pan American and the Dunlap and originated at the Minnesota Experiment Station Fruit-Breeding Farm in 1910. At certain places in Minnesota it has been reported to be more productive than the Progressive, while in other sections it has been so badly affected by leaf-spot diseases that it has been discarded. It is not recommended at present for general planting.

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THE SILVERFISH, OR "SLICKER"

AN INJURIOUS HOUSEHOLD INSECT

E. A. BACK

Entomologist in Charge of Stored Product Insect Investigations

Adult silverfish, about two and one-fourth times natural size. (Marlatt.)

FARMERS' BULLETIN 902

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology

L. O. HOWARD, Chief

Washington, D. C. October, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

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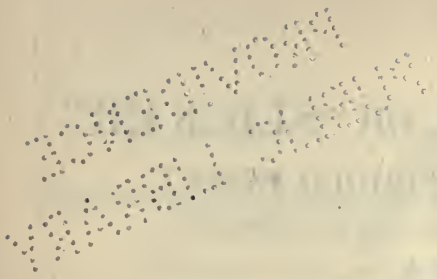

THE SILVERFISH, or "slicker," does not belong to the finny tribe but is a small, wingless, agile insect that often causes serious damage to books, clothing, and other stored and household objects while attempting to get at the starch or glue in them. It does little injury to objects in daily use or to those kept in a dry, light place.

Frequent airing of clothing, sprinkling pyrethrum insect powder about objects to be protected, and placing pieces of cardboard covered with poisoned starch where these little insects congregate are the best measures for controlling them.

THE SILVERFISH,[1] OR "SLICKER"; AN INJURIOUS HOUSEHOLD INSECT.[2]

THE SILVERFISH is that glistening, silver or pearl gray insect with three long tail-like appendages, shaped as illustrated on title-page and in figure 1, that one finds when books, papers, clothing, etc., are suddenly moved. From the dark recesses thus exposed to light the silverfish glides quickly out of sight, often thwarting all attempts to catch it. In fact, this insect is an adept at dodging, and when actually in contact with the fingers, the slick, shining body easily slips from the grasp. On account of its glistening body, its quick, gliding movements, and its ability to appear and as quickly and mysteriously disappear, it has received a number of popular names, among which are silverfish, slicker, silver louse, silver witch, sugarfish, woodfish, and bristle-tail. It occurs in both Europe and America, and, like most insects of the household, is well-nigh cosmopolitan in its distribution.

There are a number of different kinds of silverfish, perhaps the most common, aside from the subject of this paper, being the "firebrat."[3] This is a heat-loving species that is to be found in greatest numbers about fireplaces and bake ovens and may be distinguished from the common silverfish by the dusky markings on its back, as shown in figure 1.

HABITS AND INJURY.

Because the silverfish always shuns the light and has the ability to run very rapidly to places of concealment, it is not often seen and may become very abundant and cause considerable injury before its presence is noticed. The rapidity with which it runs and the slipperiness of its body, due to the scales that clothe it, make it almost impossible to catch the silverfish without crushing or damaging it.

The silverfish is one of the most serious pests of libraries, particularly in the bindings of books. Frequently it eats off the gold lettering to get at the paste beneath, or gnaws off the white label slips glued on the backs of books. Heavily glazed paper and museum labels are sometimes disfigured or destroyed by the feeding of the pest upon their surfaces. In some cases books printed on heavily sized paper will have the surface of the leaves a good deal scraped, only those portions covered by the ink being left unattacked.

The silverfish also will eat any starched clothing, linens, or lace or muslin curtains, and has been known to do very serious damage to silks which had probably been stiffened with sizing. By eating

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[1] *Lepisma saccharina* Linnaeus; order Thysanura, family Lepismatidae.

[2] This bulletin supersedes Farmers' Bulletin 681.

[3] *Thermobia domestica* (Packard).

the paste from the back of wall paper the silverfish sometimes causes the wall paper to scale off. The pest has been reported feeding upon carpets, plush coverings of furniture, and even upon certain vegetable drugs.

It is seldom that the silverfish causes damage except where its food has been left undisturbed for long periods packed away in drawers, closets, bookcases, or other such places. The pest multiplies rapidly in houses closed for the summer. It likes warmth and does little damage during winter in the North, although in the South it is active the year around, much as are cockroaches.

FIG. 1.—The "fire brat." Adult female. About twice natural size. (Marlatt.)

REMEDIES.

As stated, silverfish cause injury to clothing, books, etc., in their attempts to get at the starch or glue in them. Advantage may be taken of this craving for fabrics and other articles containing these substances to poison the insects by slipping into all the crevices where they occur—in bookshelves and backs of mantels, under washboards, and in the bottoms of drawers—pieces of cardboard on which a thin boiled starch paste, poisoned with powdered white arsenic, has been spread and dried. In making the paste the following formula should be used: Flour, 1 pint; white arsenic, ½ to ¾ ounce; water. The arsenic should be added to the flour and sufficient water used to make a thin paste by boiling. Complete relief has been secured by this measure. *Great care should be taken to keep the arsenic, the poison paste, and the poisoned bits of cardboard where young children will not get hold of them.*

Pyrethrum, or buhach powder, dusted upon bookshelves or other places where it can be used, is of value; but it must be renewed often, for it loses its power as an insecticide after long exposure to air.

For starched clothing and similar objects liable to injury, frequent handling and airing and the destruction by hand of all silverfish discovered are to be recommended, in addition to the remedies noted above. Little damage is likely to occur in houses except in comparatively moist situations or where stored objects remain undisturbed for a year or more.

COMMERCIAL EVAPORATION AND DRYING OF FRUITS

JAMES H. BEATTIE AND H. P. GOULD

Office of Horticultural and Pomological Investigations

FARMERS' BULLETIN 903

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C. September, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

THE TERMS "evaporating," "drying," "desiccating," "dehydrating," and other forms of the same root words mean substantially the same thing when applied to fruits—that is, in the end the same thing has been accomplished, the superfluous moisture in the fruit has been driven off. In common usage, however, these terms have certain variations of significance. Thus, "evaporated fruit" usually is that from which the moisture has been expelled by artificial heat in one of the common types of evaporators. "Dried fruit" commonly refers to that which has been dried by exposure to the sun. This term is habitually applied to such fruit, though it is also often applied to fruit that has been dried in an evaporator. The other terms—desiccation and dehydration—have come into use in this connection largely with the development of patented processes for the removal of the moisture from fruits and vegetables, and it is to the dried products handled by these processes that the terms are commonly applied. In reality, the other terms are equally applicable.

The desirability, not only of saving all fruit that might otherwise be wasted but of reducing large quantities to a form in which it can be kept for considerable periods of time without deterioration and be transported with the least difficulty and with the smallest demand for space, has been forced upon the country in recent months with a new meaning.

While there are some important economic features in regard to the commercial drying of some of the fruits and there may be the possibility of oversupplying the demand, it is believed, on the other hand, that even when normal conditions prevail, the use of such products, if of high grade and properly handled, could be increased very materially to the advantage of all concerned. The satisfaction with which the consumer uses dried products depends largely upon two things—a high-grade product and proper methods of preparation for consumption.

COMMERCIAL EVAPORATION AND DRYING OF FRUITS.

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PRINCIPLES AND METHODS OF DRYING.

Those who contemplate engaging in the art of drying fruits or vegetables will do well to keep in mind the fact that drying, evaporation, or desiccation, as the art of reducing the moisture content of fruits and vegetables is variously designated, adds nothing to the original product. In other words, drying will not make an inferior article better. It is therefore desirable that the fruits or vegetables be in prime condition, free from decay, and that they be handled in a sanitary manner so as to prevent contamination and deterioration.

While the moisture content of fruits and vegetables can be reduced by very simple methods, such as those used extensively in certain portions of the United States for the production of a large tonnage of dried fruits, the methods range all the way from exposing the prepared fruits or vegetables to the heat of the sun to using complicated mechanical devices for heating and artificially circulating air through and over the product to be dried.

NOTE.—This bulletin is of interest generally to all who have surplus fruit in considerable quantity for which there is not ready sale in the fresh state. Though intended primarily to aid in developing commercial activities, the information should be of value to all who wish to dry fruit for home use.

While sun drying is not extensively used in the preparation of vegetable products, it is largely used in the preparation of prunes, apricots, and peaches in California, and to a less extent for the drying of raspberries and apples in the eastern part of the United States.

This bulletin contains descriptions of devices which may be classed under the kiln, the cabinet, or the tunnel form of apparatus, depending upon the type of construction. In addition to these forms, which are of moderate cost and in extensive use in the various fruit-drying districts of the country, there are in the United States several plants of more or less intricate design erected under patents secured by their inventors which are now being used for the production of considerable quantities of dried vegetables. As these plants are privately owned and much of their installation is covered by patents, it is only possible to state the general principles upon which these factories are operated.

In a general way the equipment of these large commercial plants consists of a storage or receiving room, a preparation room, and a drying room. In the preparation room the vegetables are washed, peeled, sliced or diced, and spread upon trays, the design of which depends upon the style and type of drying apparatus used. After being spread upon trays, the vegetables pass to the drying chamber, which is usually provided with an air blast at a relatively mild temperature, seldom exceeding 150° F. Those vegetables which require cooking are placed upon trays and passed to a steam chamber, where they are cooked sufficiently to insure proper keeping when dried. From the steam chamber they are taken to the drying room, where they receive the same treatment as the vegetables which do not require cooking.

The design of the drying chamber varies in the several patented plants. One type consists of a rotary apparatus carrying the screens arranged in a chamber through which the air is circulated. Another type is a modified tunnel, through which the products to be dried slowly move on cars entering the cooler portion of the chamber and gradually passing forward to the more highly heated portion of the chamber as the finished product is removed. In still another type of drier the product to be dried is conveyed from a relatively cool portion of the apparatus on continuously moving belts, which slowly carry it through a long drying tunnel. As soon as it has passed to one end of the tunnel it is deposited on a belt moving in the opposite direction. It is transferred back and forth several times until it is sufficiently dried and is then removed at a point close to the fan where the warmest and driest air enters. A great variety of designs for manipulating the screens while in the dry chamber, for transferring the product from one portion of the chamber to another, and for

securing a continuous change of heated air over the product have been worked out in the various plants.

The expense of installing and operating these plants necessitates the production of a high-grade product, a periodic supply of fresh vegetables (usually grown under contract), and other factors essential to a successful factory system of procedure. As a result, it is considered that these plants are better suited for handling specific crops grown under contract rather than the handling of surpluses resulting from the normal acreages of various crops grown in extensive producing areas.

The simpler devices described in this bulletin are those which have been found by experience to be adapted to the purpose of conserving surplus products of the farm or community. The smallness of the plants, the fact that expert supervision is not required, and that only a small amount of energy in the form of steam or other power is necessary in their operation bring their cost and operating expense within the resources of the owner of a producing unit of moderate size.

In presenting this material, the idea of simplicity, economy, and thoroughly tested equipment has been kept in mind.

BUILDINGS AND EQUIPMENT FOR DRYING.

KILN EVAPORATORS.

The driers used in the apple-drying industry of the eastern portion of the United States are for the most part of the kiln type. This type has withstood the test of time and has been adopted in all recent forms of construction to the practical exclusion of other types. About 75 per cent of the evaporated apples produced in the eastern portion of the United States come from an area in western New York extending from the Oswego to the Niagara Rivers and varying in width from 40 to 75 miles. In this area some 2,000 commercial driers, practically all of the kiln type, are located, 500 being large plants. Other States also produce considerable quantities of evaporated apples, most of which are prepared in kiln driers. Among these may be mentioned Virginia, Illinois, Arkansas, and Missouri. The almost universal use of the kiln drier has been brought about by the low first cost of the kilns, the small amount of labor required to operate them, and, to a certain degree, because their construction and operation are well understood by the class of help available in the apple-drying districts.

THE KILN.

The dry kiln has been improved and modified until as now constructed it consists of a structure two stories in height, the first or ground floor being occupied by a furnace inclosed in a concrete or

masonry room for distributing the heat, as shown in figure 1, and the second floor, which is of slat construction, serving as the drying floor. The walls extend above the drying floor far enough to give sufficient headroom for working in the kiln and support the roof, which is fitted with ventilators for removing the moisture-laden air as it rises from the material being dried.

The ground plan and cross section of a typical kiln are illustrated in figure 1. It will be noted that the kiln is 20 by 20 feet, the standard dimensions of a kiln of this type. The distance from the

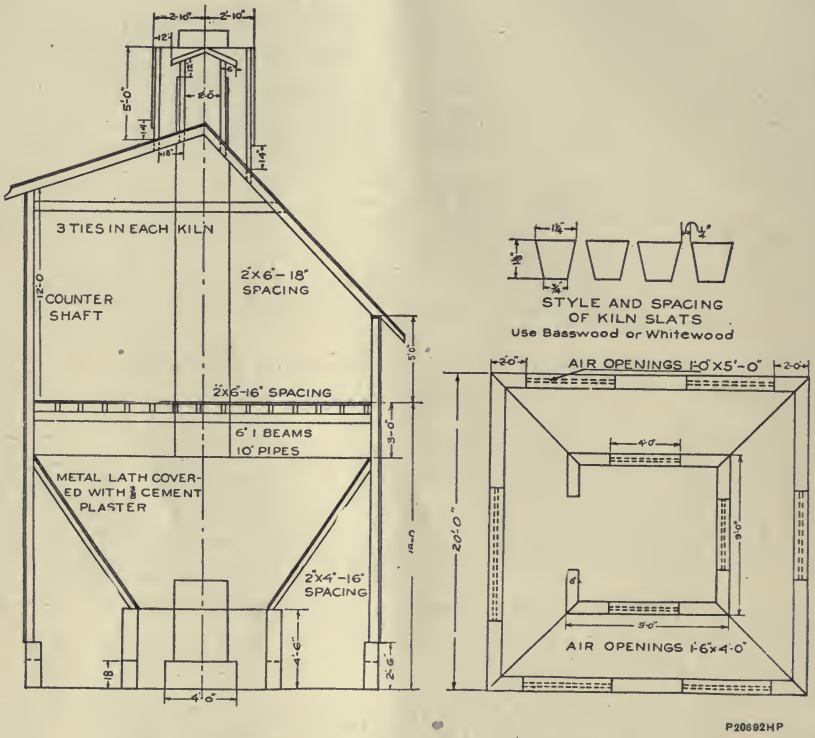

FIG. 1.—Cross section and ground plan of a kiln. When the kilns are built in rows the furnace rooms are not separated, but the furnaces have separate inclosures and hoppers for distributing the heat. The drying floors are separated by walls.

furnace floor to the drying floor is 16 feet. In order to give sufficient headroom for the storage room or workroom on the second floor along the side of the kiln, the roof on one side is not as steep as on the other side. The roof is so constructed that the ridge is in the middle of the building, with the ventilators along the ridge.

Foundation.—The foundation for the kiln may consist of any suitable material, its depth being determined by the nature of the subsoil and the character of the building material to be used for the superstructure. Concrete is the best foundation material, as, when

once properly set, it is impossible for water to get under it and cause damage by freezing. Whatever the material used, the foundation walls should be of sufficient size to support the building without settling, as even slight settling throws the machinery out of alignment and causes leaks in the heating apparatus and in the hopper. If the walls of the kiln are to be of frame construction, the foundation is usually 2½ feet above the surface of the ground, in order to make room for the air vents, to have the floors sufficiently high to prevent decay, and to give ample room for the circulation of air under the preparation room or workroom floor, as part of the air supply for the kiln must pass under this floor. When the walls of the kiln are of stone, brick, or masonry of any sort, the foundation is carried up only to the surface of the ground or far enough above to make it level, and the walls are started directly on this. The air ducts, described later, are placed in the walls below the level of the workroom floor.

Walls.—The walls of most of the dry kilns are constructed of wood. Concrete, concrete blocks, hollow tile, brick, or stone makes a more durable structure, but the first cost is considerably higher. Wood kilns demand frequent repairs, are short lived, and take a higher rate of insurance than kilns made of other material. The most economical material to use must be determined by local conditions; if concrete is cheap in a particular locality, that may be the best material. The details of the construction of the kiln must be determined by the material used for the walls, but the interior dimensions remain the same irrespective of the kind of material selected. In the usual type of wood construction, the walls are made by setting 2 by 6 inch studding 16 inches apart, measured center to center. On the outside of the studding a layer of sheathing boards is placed diagonally. A layer of building paper is then applied, and the siding placed on the outside of this. When cement blocks are used, the wall, as a rule, is made 8 inches thick. The same dimension is used for hollow tile or brick. When stone is used, the walls must be 10 to 12 inches thick. Whatever the material used, the doors, windows, and other openings are the same size and the interior dimensions of the kiln are the same.

Roof and ventilators.—The roof is always of frame construction, consisting of 2 by 6 inch rafters spaced 24 inches apart and covered with sheathing and an asphaltum roofing paper. Metal roofing is not well adapted to kilns, as the sulphur fumes used in bleaching the apples soon corrode the metal. The method of constructing the roof is shown in figure 1. The type of ventilator used on practically all modern kilns is shown in the same figure. The ventilators are always placed at the peak of the roof, so that the moisture-laden air will be removed quickly. This type of ventilator has been found to be wind

and rain proof. No matter which way the wind blows the kiln is sure to draw. The wind passes through the opening between the roof and the outside wall of the ventilator and causes suction, which tends to create a draft from the interior of the kiln. Rain on the roof of the ventilator falls between the outside and inside walls of the ventilator, strikes the main roof, and runs off. Figure 2 shows a drying plant equipped with ventilators of this type. Other styles of ventilators are used, but are not as efficient as the type just described.

Heating apparatus.—Cast-iron, hard-coal furnaces are universally used in apple kilns. These furnaces have a grate of 5 to 8 square feet and are capable of supplying heat for a standard 20 by 20 foot

P383SHP

FIG. 2.—Drying plant at Victor, N. Y., equipped with modern ventilators.

kiln. The products of combustion pass through sheet-iron pipes arranged in rows under the floor and finally into the chimney. Three systems of piping are in use, all of which are illustrated in figure 3. The difference in these systems consists in the amount and the distribution of the pipes under the drying floor. In all these systems a section of 10-inch pipe 4½ feet long is placed on top of the furnace. This reaches a point about the same distance from the drying floor. The course of the hot gases in the different systems may be followed by referring to this illustration. The outside row of pipes is placed about 22 inches from the wall of the kiln. The whole piping system is given a gradual rise from the furnace to the flue. At the point where the pipe enters the flue the pipes are about 2 feet below the joist of the drying floor. Some furnaces are fitted with two openings

for pipes, and with this type of furnace one opening is used for each side of the kiln and the pipes are joined with a tee just before entering the chimney. The system having the most radiating pipes are the most efficient, but the cost of repairs is, of course, higher. The second system described is used to a greater extent than any of the others.

Chimneys.—As it is the practice to build the kilns in rows, it is the usual custom to build a 2-flue chimney in the wall between two kilns to serve both furnaces. The chimneys have two 8 by 10 inch flues and must be carried above the highest part of the building, so there will be a good draft.

Fuel.—Practically all the furnaces on the market are adapted to the use of hard coal. Wood is sometimes used, but it is claimed that the odor of the wood imparts a disagreeable flavor to the fruit. It is impracticable to use soft coal, on account of the soot and smoke.

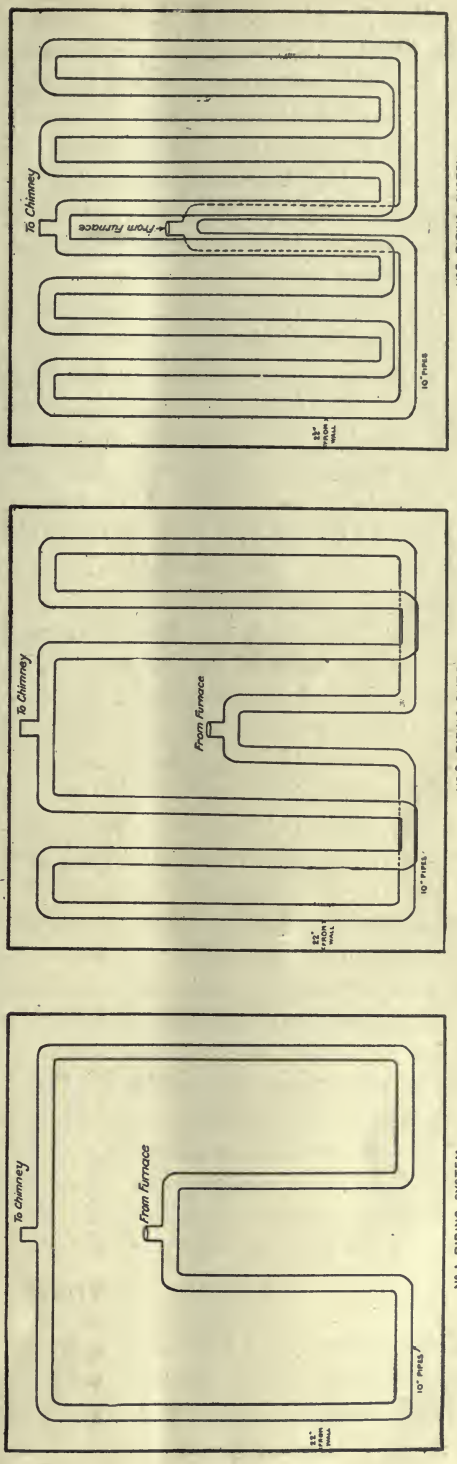

FIG. 3.—Diagrams showing three different methods of piping kiln driers. System No. 1 is in frequent use, but No. 2 is more efficient and the one most frequently used. While system No. 3 is the most efficient, it is rather expensive to install and to maintain. The products of combustion pass through the piping system and finally to the chimney.

Distributing hopper and air ducts.—Drying in these kilns depends on passing heated air through the material which is spread on the drying floor. It is necessary to have suitable openings, so that cold air can be admitted at the bottom of the kiln, be heated by being passed over the furnace and its piping, and, after passing through the material to be dried, discharged through the ventilators at the top of the building. The sizes and location of the ducts for the inlet of the air are shown in figure 1. These ducts are 1½ feet high by 5 feet long, and are four in number, two on each side of the kilns. When the kilns are built in rows, two air ducts are placed in each side wall and the partition walls between the furnace rooms of the individual kilns are omitted. This is brought out in figure 4. To give more uniform results, the furnace is set in a square concrete or masonry inclosure. This is a comparatively recent improvement in kiln construction. It consists of a concrete inclosure 9 feet square and 4½ feet high directly in the middle of the furnace room. This has three openings, each 18 inches by 4 feet, on three sides of the inclosure, and the fourth side has a portion 4 feet wide cut away to serve as a fire door. The upper portion of this opening is covered with a sheet-iron door. On top of this wall a hopperlike structure is built, the bottom corresponding to the top of the concrete inclosure and the top meeting the side walls of the kiln at a point 3 feet below the drying floor and 13 feet from the ground. The frame of this hopper is of 2 by 4 inch scantling, covered on the inside with metal laths and three-eighths of an inch of cement plaster. The sides of the hopper are made perfectly tight, so that no air can reach the drying floor without entering the bottom of the hopper through the air ducts. The details of construction are shown in figure 1.

The drying floor.—The drying floor carries considerable weight and must be strong. The usual type of construction is to have two wood or steel beams set into the side walls of the kiln and spaced evenly. The joists are placed at right angles to these girders and are set back into the wall at either end. The slats that make the drying floor proper are of whitewood or basswood, 1⅛ inches thick, and 1¼ inches wide on the upper side and three-fourths of an inch on the side next the joist. In cross section they are keystone shaped. They are placed one-fourth of an inch apart. The floor strips should run at right angles to the side of the kiln containing the door, so that it will be easy to handle the product with shovels.

THE KILN DRYING PLANT.

Several individual kilns constitute a drying plant. As it is necessary to have enough drying capacity to keep the machinery and help employed, the number of kilns in a plant varies, but an economically

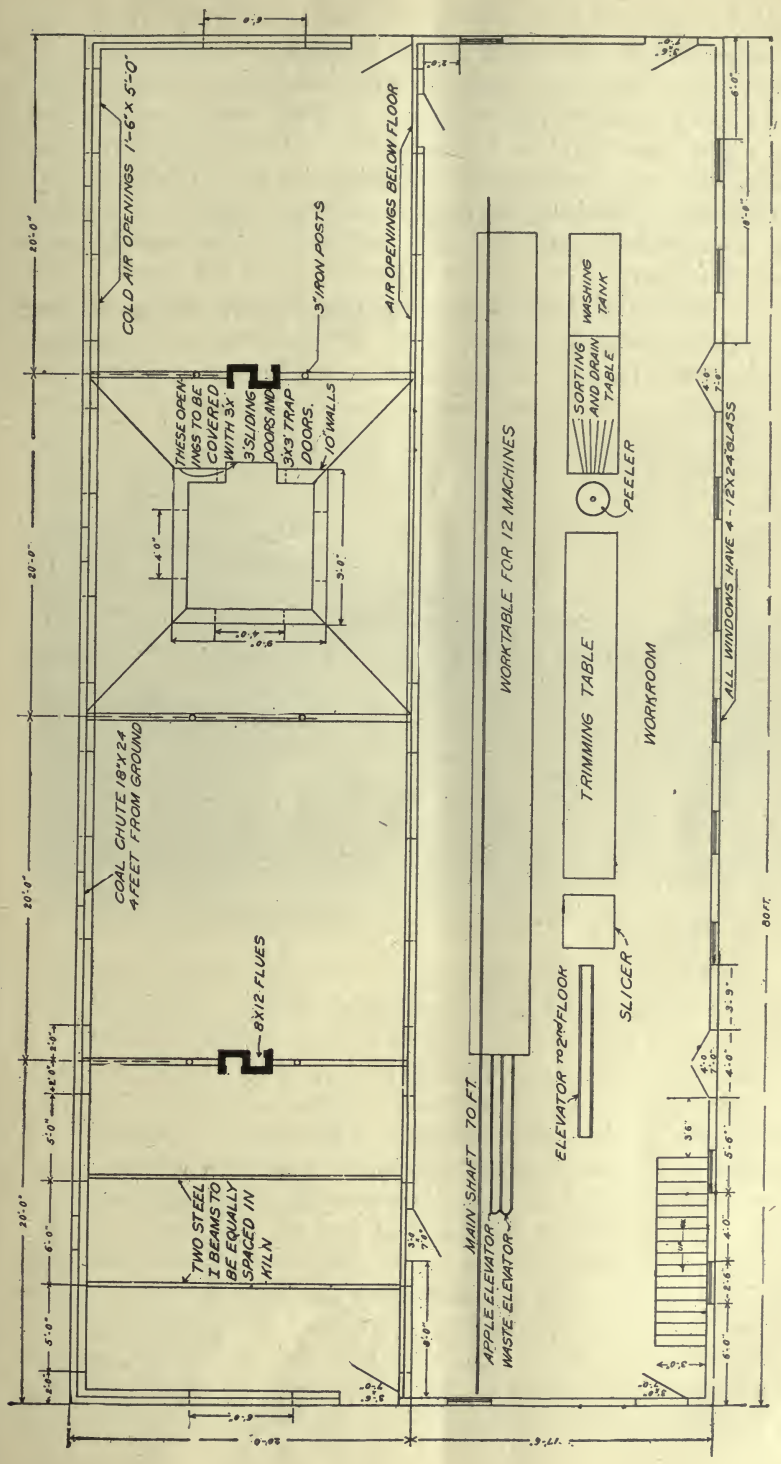

FIG. 4.—Ground-floor plan of a 4-kiln evaporating plant. If the kilns are to be used for vegetable drying, the additional equipment may be installed in the workroom without disturbing the apple-drying equipment.

sized plant consists of four kilns built in a row with the workrooms along one side. A plant of this size is large enough to keep the operators busy, and plants larger than this increase the fire risk without adding much to the economy. A plan sometimes followed when a larger capacity than is offered by the 4-kiln plant is desired is to erect two sets, separated by a space of 75 to 100 feet, with an overhead bridge connecting the two sets of kilns. One set of machinery and one workroom serve for both, yet the fire risk is considerably reduced.

Location of the plant.—The drying plant is, of course, located near extensive orchards. Each 20 by 20 foot kiln will evaporate from 120 to 150 bushels of apples every 24 hours, a 4-kiln plant operated for 60 days evaporating 20,000 or 25,000 bushels of apples.

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FIG. 5.—A large drying plant with the storage bins located along the side of the workroom.

If the venture is to be profitable, sufficient fruit must be available to keep the plant busy for the maximum period. The plant must be located where help can be secured and the product shipped. If it is to be used for drying vegetables, an abundant supply of water must be available.

Arrangement of the plant.—When a 4-kiln unit is used the kilns are usually arranged in a row with the work and storage rooms along one side. The first-floor plan of such a plant is shown in figure 4. The structure is 80 feet long and the kiln portion 20 feet wide. The workroom portion is 17½ feet wide and 80 feet long. The furnace floor is dirt at the ground level, while the workroom floor is on top of the foundation. Steps lead down from the workroom to the furnace room. Usually one end of the workroom is partitioned off and used as an office, for supplies, or sometimes as bins. Frequently the bins are built outside the kiln in a row along

the main building, as shown in figure 5. In other cases the bins are covered, as shown in figure 6. Both these illustrations show typical drying plants. Figure 5 is one of all-wood construction; and figure 6 is one with stone walls up to the drying floor and the remainder of wood.

The workroom on the second floor is taken up with the slicer and a space for conditioning the evaporated material. The bleacher is swung from the rafters 6½ feet above the floor, so that there is headroom to enter the kilns. The plan of the second floor and the location and size of the bleacher are shown in figure 7. The floor of the conditioning room is level with the drying floors of the kilns, in order to facilitate handling the material. A stairway is provided between

P3884HP

FIG. 6.—A drying plant with the storage bins under cover. The building is of frame construction with the exception of the walls of the kiln up to the drying floor, which are of stone. This plant has a capacity of 400 to 600 bushels of fresh fruit during each 24 hours.

the first and second floors. The location of the windows and doors and the size of these various openings are shown in figures 4 and 7.

Equipment of apple kilns.—Aside from the furnaces and piping already described, a fully equipped apple-drying plant contains (1) a washing tank, (2) a grader, (3) a worktable fitted with belt conveyors for the apples and waste, (4) peeling machines, (5) elevators for carrying the apples and waste to the second floor, (6) a chopper for the waste, (7) the bleacher (the sulphur stove and the operating mechanism), (8) the slicer, (9) baskets, wooden shovels, trimming knives, etc., for handling the material, and (10) shafting, belting, pulleys, and an electric motor or a gasoline engine to operate the machinery. The relation of the various items of the equipment is shown in figures 4 and 7.

The apples are brought into the building through a doorway near the end of the paring table and either placed directly on the paring table or washed, graded, and elevated to the second floor by a belt conveyor, whence they are carried to the paring table by chutes. Belt conveyors are placed on the paring table, one for the waste and one for the pared apples. The pared apples, after trimming, are carried by an endless chain elevator to the bleacher on the second floor. From the bleacher the apples go to the slicer, and finally to the kilns to be dried. The slicer must be of sufficient capacity to handle 400 bushels a day. If more material is to be handled, additional slicers should be provided. The waste is delivered from the worktable to the chopper, then elevated to the second floor, discharged into baskets, and carried to the drying floor. This waste

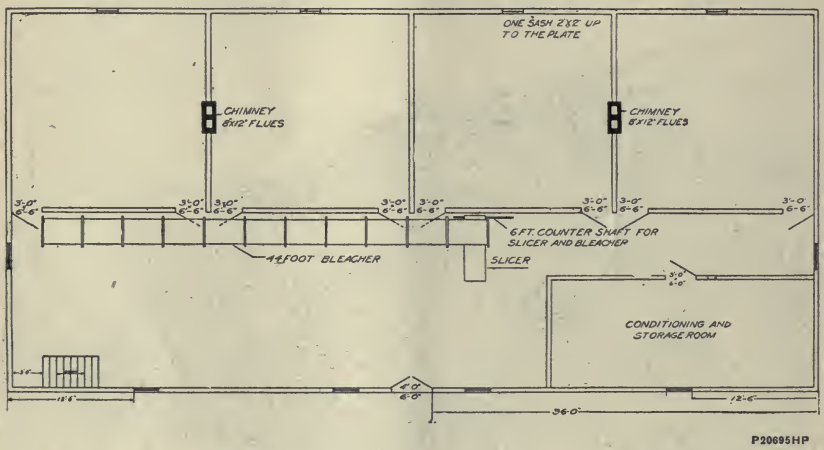

FIG. 7.—Second-floor plan of a 4-kiln drying plant. The drying floor and workroom are on the same level. The bleacher is hung from the rafters with sufficient headroom for passing into the kiln.

material is sold to vinegar manufacturers and makers of jelly products. The evaporated product is conditioned after removal from the kiln and then packed for shipment. The packing room is usually separated from the remainder of the second floor.

Adapting apple kilns for drying vegetables.—The apple kilns may be used for drying certain vegetables, the only necessary change being to spread cheesecloth on the floors to prevent the material from falling through. The equipment necessary for vegetables consists of (1) power, (2) washing vats for the root crops, (3) peeling machines and a suitable system to supply water for the washing vats and the peeler, (4) shredding machines (for celery, cabbage, onions, and similar crops) or slicing machines (for carrots, beets, etc.), (5) elevators for carrying the material to the drying floors, and (6) baskets, shovels, trays, etc., for handling the vegetables. When the drier is

used for both apples and vegetables the special equipment for vegetables may be installed without making extensive changes in the apple-handling equipment. Figure 4 shows the plan of a floor equipped for drying both apples and vegetables.

Advantages and disadvantages of apple kilns.—The present apple kiln is the result of a process of elimination of many different types extensively used during the history of the apple-drying industry. It is simple, easily built, and low in first cost; and the amount of labor necessary to operate it is small. That it is the best type of kiln is by no means certain, but as long as the market demands such a grade of evaporated apples as is produced in these kilns it is not likely that any other type will be generally used. In order to handle the material it is necessary to walk on the floors on which it is spread to be dried. Unless care is exercised the product is liable to be unclean. These kilns could be improved in this respect by having narrow walk ways, so that the workmen could spread, turn, and remove the product without touching it with their feet. Kilns of this kind have been used with satisfactory results for drying cabbage, carrots, beets, celery, turnips, and onions. Owing to the fact that they may be built on short notice, for the most part out of materials to be secured from any lumberyard and a hardware store, they can be erected and used as emergency driers for conserving surplus vegetable crops in sections where this material is likely to be wasted.

STEAM-HEATED CABINET DRIERS.

A type of drier used extensively for dehydrating apples, peaches, cherries, berries, and several vegetables, such as onions, carrots, cabbage, celery, turnips, and potatoes, has been developed in northern New York and Canada and is used in large numbers in the sections mentioned for drying material for shipment to the allied armies in France. It has been found that this drier is much more efficient than the kiln type, makes a product of a better grade, and is adapted to use in any locality, as any fuel may be used to generate steam. These driers are built in units, each unit having approximately the same capacity as a 20 by 20 foot kiln.

The following description refers to a single unit, but several of these units are combined to constitute a drying plant, as it would be impossible to keep the help occupied with a single unit. Each unit is 18 feet long, 7 feet wide, and about 10 feet high to the slope. It is made up of rows of steam pipes fed from a common header at the top, with steam circulating back and forth through these pipes and finally returning to the boiler by means of a return pipe from the header at the bottom. There are six rows of 1-inch steam pipe with 24 pipes in each row, 17 feet 6 inches long, and two rows with the same number of pipes in each row, each 17 feet 2 inches long.

The rows of pipes are so spaced that it is possible to put two trays, one on top of the other, between every two rows of pipes, each tray being 3 inches deep. In this drier the rows of pipes are 14 inches apart at one end and 8 inches apart at the other, thus giving each row of pipes a 3-inch fall in the length of the drier and insuring good circulation and quick removal of the condensation. A side view showing the arrangement of the pipes is given in figure 8. This illustration also shows the framework used to support the steam

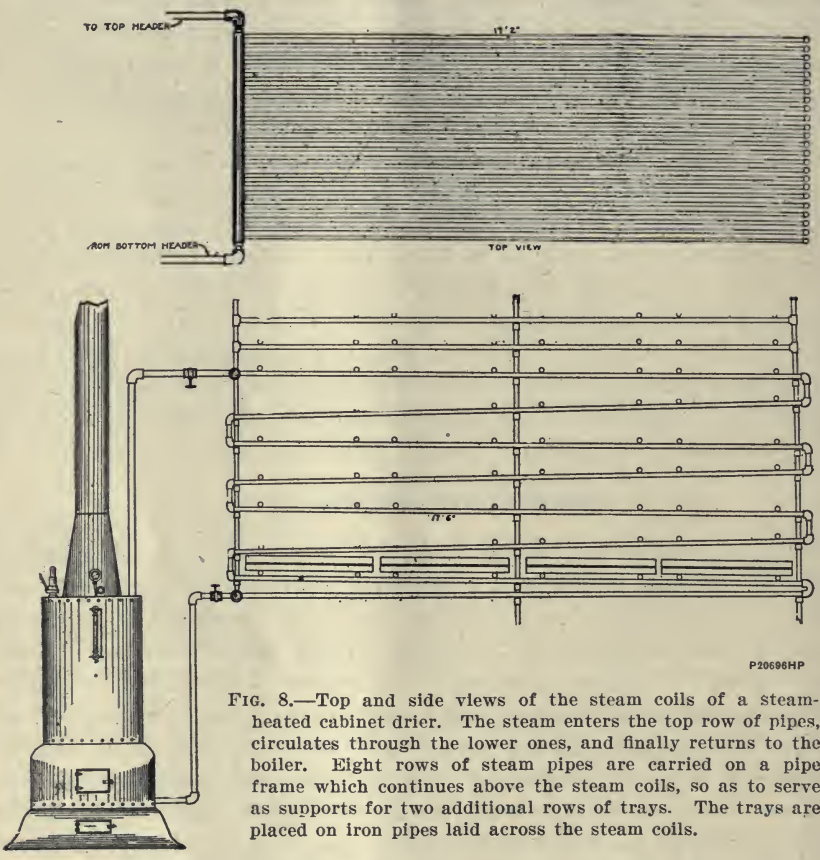

FIG. 8.—Top and side views of the steam coils of a steam-heated cabinet drier. The steam enters the top row of pipes, circulates through the lower ones, and finally returns to the boiler. Eight rows of steam pipes are carried on a pipe frame which continues above the steam coils, so as to serve as supports for two additional rows of trays. The trays are placed on iron pipes laid across the steam coils.

coils. This framework is built up of 1-inch iron pipe and fittings to match. The dimensions of this framework are such that it gives the row of pipes the fall mentioned above (3 inches). A 20-horse-power boiler is sufficient to supply steam for one of these units. As a matter of fact, a boiler of sufficient capacity to supply steam for all the units in the plant is better than a single boiler for each of these units.

Pieces of 1-inch pipe are laid across the steam coils to serve as runners for the trays. The steam coils are inclosed in a cabinetlike

structure, illustrated in figure 9. This structure is 18 feet long, 7 feet deep, and about 10 feet high. Doors are provided in front of each space for the steam coils, so that the trays may be placed in the drier and removed without interfering with the trays in other sections of the drier. These doors are 8 inches high and in two sec-

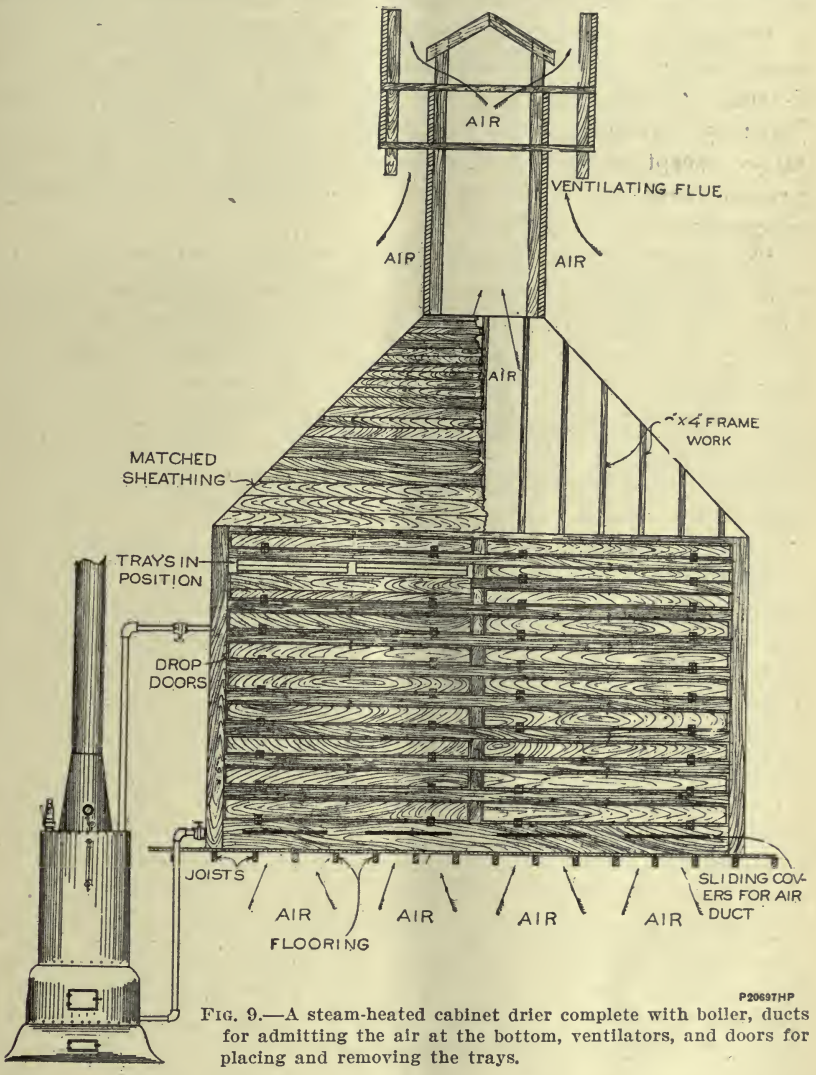

FIG. 9.—A steam-heated cabinet drier complete with boiler, ducts for admitting the air at the bottom, ventilators, and doors for placing and removing the trays.

tions and run the length of the drier. The ends of this cabinet are built in sections and have no doors, but the sections are made so that they can be removed for access to the steam pipes for repairs and other purposes. It is usually the practice to place two of these units back to back, with the doors on the outside. An inverted hopper is built on top of each drier, which terminates in a 3 by 4 foot wooden

flue for removing the moisture-laden air from the drying material. This flue has a protected ventilator at the top, so that it is rain and wind proof.

The trays are 3½ by 4 feet and 3 inches deep, so that two tiers of two trays each may be placed in the same compartment of the drier. A framework is carried above the steam pipes in such a way as to accommodate two additional rows of trays. For most vegetables 72 trays are used and 144 for a few, chief of which are potatoes. The trays have galvanized-wire bottoms of ¼-inch mesh for all vegetables except potatoes and a 1-inch mesh for these. The steam pressure used in this drier varies with the material to be dried and ranges from 60 to 70 pounds.

This type of drier has been worked out after years of experience with steam driers of various types and seems to offer many advantages over other types for the drying of vegetables. In the first place, it may be used with any fuel that will generate steam. The drier itself can be built of materials to be secured at any lumberyard and a plumbing-supply house. No special material is used. Moreover, it is possible to erect these driers in a very short time; in fact, it is the practice among operators using this type to take it down and move it from place to place on short notice. Two experienced men will set up the steam coils on this drier in a day. The nipples used to connect the rows of steam pipes are right and left, so that the coils can be dismantled very quickly. It is possible to find in almost any town a vacant building that has boiler capacity already installed. These drying units may be set on the third floor of any building, so that they will have a supply of air from underneath, it being necessary to furnish them with some means of getting rid of the moisture-laden air as it rises from the stacks. This might be carried off through a duct by means of a fan. The capacity of these units is such that a plant of comparatively large capacity can be installed in a small space. In the case of the portable units it is possible to use them in emergency drying in sections where there happens to be an oversupply of perishable material; then take them down and move them to another locality on short notice. The dimensions of these units are such that three of them can be mounted on an ordinary flat car and a portable boiler on another and, with the drier, moved from place to place as required.

The equipment necessary to prepare vegetables for drying is comparatively simple. A plant with a capacity of 500 bushels of vegetables a day can be carried on two ordinary 60-foot flat cars.

TUNNEL DRIERS.

The labor involved in drying fruits and vegetables in tunnel driers is greater than in the kiln type, and for this and other reasons they

have never come into general use in the apple-drying districts of the eastern portion of the United States. Wherever berries, cherries, corn, or other material best handled by spreading on trays constitute a considerable portion of the product, tunnel evaporators may be used advantageously.

In its essential features, the tunnel evaporator consists of a long, narrow compartment with the floor and the ceiling inclined uniformly from end to end and a furnace below the floor. The room is cut into a series of narrow chambers, or tunnels, by parallel partitions. In some of the larger plants the trays are loaded on trucks fitted with a framework to separate and support them, which enter the tunnel at the upper end. The dry fruit is removed at the lower end by removing the trucks. As one truck is removed at the lower end, another loaded with fresh fruit is placed in the upper end. This arrangement is objectionable, in that it is impossible to inspect the drying material without removing all the trucks. A better arrangement is to have a framework of studding carrying cleats which form a track for the trays. These cleats are arranged one set above another, with the same slope as the tunnel. The trays are pushed in at the upper end of the tunnel and removed at the lower end, sliding on the cleats.

The standard 20 by 6 by 3 feet tunnel accommodates 18 tiers of trays with 5 trays in a tier, or 80 trays in all, capable of drying about 2,200 pounds of fresh apples at one charge. Figuring on a 24-hour basis, which is the usual custom, a set of three tunnels heated by one furnace is capable of drying about 200 bushels of apples a day. In other words, two sets of 3-tunnel units have the same capacity as a 4-kiln plant and require the same force for peeling and preparing the material. More labor is required for the drying itself than is the case with the kilns.

The floor of the tunnel slopes uniformly from end to end, the inclination generally being 1½ or 2 inches per foot of length. Two different types of construction are employed. In one the tunnel is tightly floored with sheet iron throughout its length except a space 2 to 4 feet long over the furnace. The other type has no floor. In both types the furnace is fitted with a system of piping similar to that used in the kiln evaporators. The ends of the tunnels are large enough for placing and removing the trays. The construction of the original tunnel is shown in figure 10. The ventilators for a set of three of these tunnels must not be less than 2 by 5 feet in cross section and high enough so that there will be a good draft. The ventilators are similar in construction to those used on the kiln driers. The tunnels are built side by side, three tunnels being heated by one furnace of the size employed for a 20 by 20 foot kiln drier.

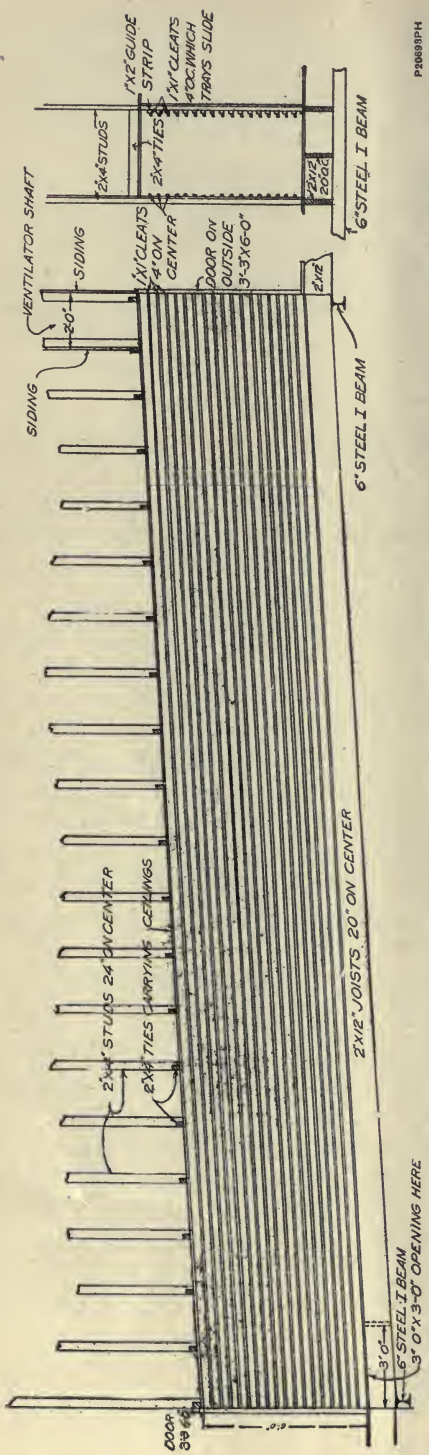

FIG. 10.—Cross section and end section of a tunnel drier, showing the arrangement of the trays and giving the dimensions of the parts.

Tunnel driers are built of wood, concrete, stone, brick, tile, or other building material. Frame construction, while low in first cost, is subject to rapid depreciation and greater fire risk. All that has been said in reference to building materials for kiln driers applies equally well to tunnel driers. The more permanent building materials, although high in first cost, may be more economical in the long run.

The number of tunnels to be constructed must be determined by the volume of fruit to be handled. A tunnel drying plant containing 12 tunnels may be built in the same space necessary for a 4-kiln plant. Figures 11, 12*A*, and 12*B* give plans for such a plant. This plant is capable of handling 600 to 800 bushels of apples in 24 hours.

The tunnel drying plant has much to recommend it, and it is probable that it will be more generally used than in the past. It is possible to make a product of better grade than with kiln driers, and as the demand for dried vegetables and higher grade evaporated fruit increases it is likely that more attention will be devoted to the tunnel drier.

SMALL DRIERS OR EVAPORATORS.

Many persons produce quantities of fruits and vegetables, though insufficient to

justify the erection of any of the driers or evaporators here described. For handling this surplus, portable or other forms of cabinet evaporators of small capacity are commonly used. Such equipment is, as a rule, operated by members of the family and the product is sold locally.

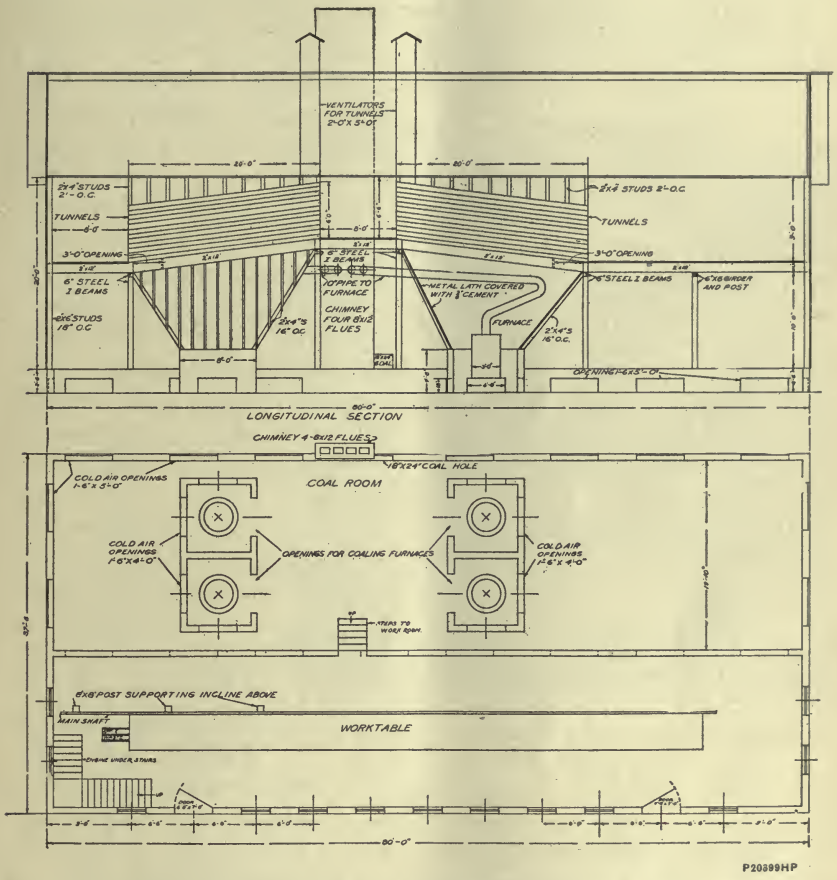

FIG. 11.—First-floor plan and elevator of a tunnel drying plant. This plant has the same outside dimensions as the 4-kiln plant, but twice the capacity.

These driers or evaporators are filled with trays for holding the material to be dried, these trays being arranged one above the other in the drier. A ventilator is placed at the apex of the roof, and the heat is supplied either by a stove or by steam coils in the lower part of the drier.

Figure 13 shows an evaporator heated by a stove in the lower part.

There are several styles of portable evaporators obtainable from manufacturers which are made of sheet iron, usually galvanized. As

no wood enters into their construction, danger from fire is eliminated. One of these styles is provided with a heat deflector, and is so con-

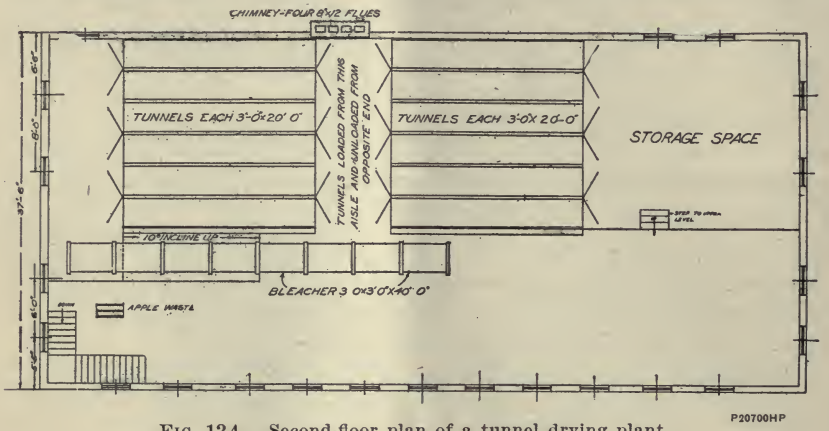

FIG. 12*A*.—Second-floor plan of a tunnel drying plant.

structed that hot currents of air pass over the fruit as well as up through it, the claim being made that this movement of air induces

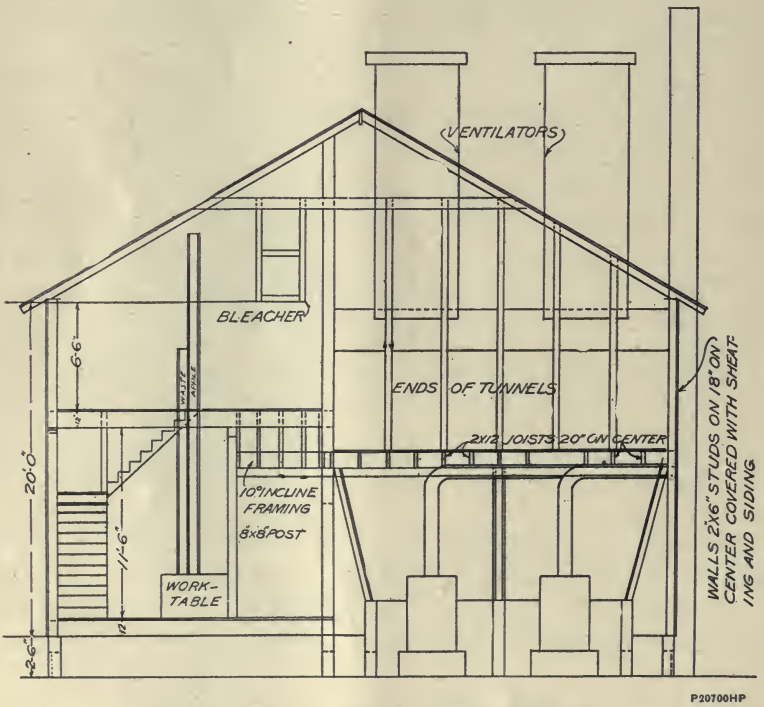

FIG. 12*B*.—End elevation of a tunnel drying plant.

a more rapid drying of the fruit than is obtained in ordinary methods of construction.

EVAPORATING FRUITS BY ARTIFICIAL HEAT.

APPLES.

FRUIT SUITABE FOR EVAPORATION.

There is an increasing demand for evaporated[1] apples of the highest quality. The tendency has sometimes been to make quantity at the expense of quality. But prices are governed not only by the supply but also by the grade. The cleanest, whitest fruit, that is well cored, trimmed, bleached, ringed, and dried, is most in demand. Carelessness in any particular injures the product.

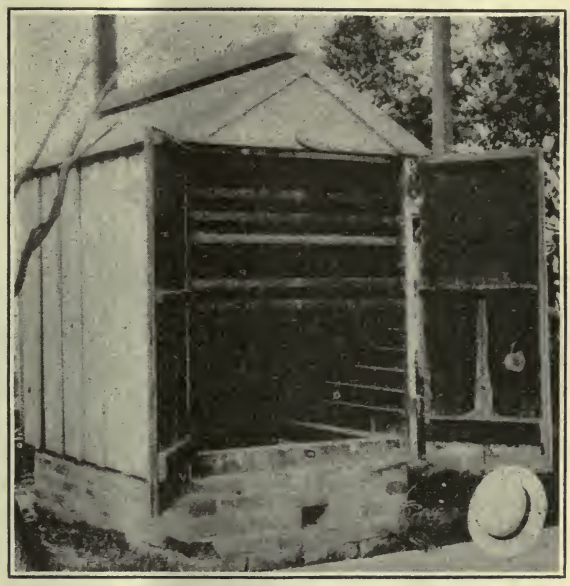

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FIG. 13.—A small farm drier constructed of wood.

Primarily, the economic usefulness of an apple evaporator is through its utilization of windfalls and grades of fruit which can not be marketed to good advantage in a fresh state, and it is these grades that are most often evaporated. But the magnitude of the crop also influences the grade of the evaporated product in a decided way. In seasons of abundant crops and low prices for fresh fruit, large quantities of apples that would ordinarily be barreled are evaporated, and the grade of stock produced is correspondingly improved. On the other hand, in years of scanty crops, when all apples that can possibly be shipped are in demand at high prices, only the very poorest fruit is evaporated, as a rule, thus lowering the average grade of the output.

The commercial grading of evaporated apples is based primarily on appearance rather than on dessert quality, and the fact that one variety may make a better flavored product than another is not

[1] The terms "evaporated," "dried," "desiccated," "dehydrated," etc., are used more or less interchangeably when applied to fruits from which the moisture has been removed, without any definitely fixed significance. In a general way, however, "evaporated fruit" is that from which the moisture has been removed through the agency of artificial heat; similarly, "dried fruit" is that which has been exposed to the heat of the sun, though not infrequently the term is applied to fruit that has been handled in the evaporator. The other terms are commonly applied to fruit that has been evaporated by one of the various patented processes in which equipment of some special design has been used.

considered. As a rule, a product of high commercial grade can be made from any sort which has a firm texture and bleaches to a satisfactory degree of whiteness. A variety of high dessert quality, such as the Northern Spy, may be expected to make an evaporated product of correspondingly high flavor.

In sections where the Baldwin apple is grown extensively it is in demand at the commercial evaporators, as it meets the requirements in a fair degree and is also available in relatively large quantities. In the Ben Davis sections that variety supplies a similar demand.

Most early varieties lack sufficient firmness of texture for the best results and are undesirable on this account. On the other hand, some comparatively early sorts, such as Gravenstein and Porter (*Yellow Summer Pearmain*), are considerably prized in some sections; the dessert quality of the Porter is especially high.

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FIG. 14.—A pile of evaporated apples going through the sweating process in a curing room connected with a New York evaporator.

Similarly, the product made from other sorts possesses qualities that are due more or less to varietal characteristics. For instance, that from Esopus is said to be unusually white; Hubbardston and varieties of the Russet group also make very white stock. The latter make relatively a large amount of stock, by weight, to a given quantity of fresh fruit. Limbertwig is said to produce from 1½ to 2 pounds per bushel more of dried stock than most sorts do, but it is not so white as that from some other varieties.

PREPARING THE FRUIT FOR EVAPORATION.

Paring.—No special comments are necessary under the head of paring, save to mention this step in the order in which it occurs in the preparation of the apples for drying. The apples are cored in the same operation by an attachment applied to the paring machine for

this purpose. The fruit is automatically forced from the fork and drops to the table, where it is next taken in hand by the trimmers. In the smaller evaporators the slicing is often done at the time of paring by a slicing attachment applied to the parers.

In nearly all the evaporators the paring and trimming are done by women and girls.

Trimming.—In paring the fruit there is usually more or less skin left around the stem and calyx of the apples and any irregular places that may occur. There will be wormholes, decayed spots, and other blemishes which will detract from the appearance of the product, if allowed to remain. Even bruises are objected to by the most exacting operators. Hence all such defects are cut out as soon as the fruit is pared if the highest grade of product is expected. This is done with an ordinary straight-back, sharp-pointed knife, having a blade 2½ to 3 inches long.

Bleaching.—The fumes of burning sulphur are employed not only to make the fruit white where the freshly cut surfaces have become discolored by contact with the air, but to prevent further discoloration after it is sliced. Sulphuring is also generally supposed to be necessary to destroy fungi and insects, though under present methods of handling this is open to question.

There are no definite standards governing the bleaching as to the time required, amount of sulphur necessary to accomplish the desired end, etc. The aim is to treat until enough of the fumes have been absorbed by the apples to prevent discoloration after they are sliced and exposed to the air. If it is found that the fruit is not retaining its clean, white appearance with the treatment that is being given, either the length of time that the fruit is kept in the bleacher is increased or more sulphur is burned in the customary time for bleaching. Due caution should be exercised, however, in this connection, inasmuch as the bleaching of desiccated fruits with sulphur fumes is open to criticism. The sale of fruit containing sulphurous acid in any considerable quantity is prohibited by the pure-food laws of some States, as well as being restricted in some of the foreign markets. Under the Federal pure-food law restrictions are also established with a view to limiting the sulphur dioxid content to reasonable bounds. (See p. 59.)

In many cases the bleaching process is doubtless continued much longer than is necessary for the desired results. Until some definite standards are established and recognized, the greatest care should be exercised not to bleach more than the minimum required to maintain the desired color a reasonable length of time.

The allotted time for bleaching, in a large number of evaporators from which information has been obtained, varies from 20 minutes to 1½ hours. The more usual time appears to be about 45 minutes.

This, however, may be regulated in a measure by the amount of sulphur burned in a given time.

The estimates regarding the amount of sulphur used to bleach a ton of fruit vary from 4 or 5 pounds to 20 pounds, though but little information of a definite character is to be obtained at present.

The usual practice is to start the sulphur fumes by putting a few live coals into the receptacle used for the purpose, then adding a small piece or two of stick brimstone. Before this has all been vaporized, more is added. This is continued as long as the bleacher is in operation, sufficient heat being generated to vaporize the sulphur without the further addition of burning coals.

When apples are dried whole, without slicing or quartering, they require less bleaching than if they are to be sliced, inasmuch as the interior of the fruit does not come in contact with the air.

For the most satisfactory results, it is essential that the fruit be put into the bleacher in the shortest possible time after the surface is exposed to the air by paring. If a long delay occurs, the surface becomes disclored, in which case it does not regain its original whiteness in the bleaching process.

A method used in Australia (New South Wales) is to slice the apples before bleaching, drop the slices into a brine made by dissolving salt in water at the rate of 2 ounces to the gallon, letting them remain from 5 to 15 minutes, followed by bleaching 10 to 20 minutes. The relative value of this method, if any, is in reducing the time the fruit is in the bleacher.

Slicing, quartering, etc.—After bleaching, the next step in preparing the fruit is slicing, unless instead of slicing it is quartered or dried whole, as is done to a limited extent. In preparing fruit for some of the smaller evaporators, as previously mentioned, the slicing is done when the fruit is pared; the bleaching then follows the slicing instead of preceding it.

The slices are one-fourth of an inch in thickness, and in the largest degree possible should be cut at right angles to the hole made through the axis of the apple when the core is removed by the parer, thus producing the rings, which is the form most desired. Other things being equal, that fruit is sliced the best which contains the largest proportion of rings, and this point is given more or less weight in grading the finished product.

When it is desired to evaporate apples in quarters or sixths they are run through machines which cut them accordingly, the cutting being done in the opposite direction from the slicing; that is, in a direction parallel to instead of at right angles to the axis of the apple.

If they are to be dried whole they are transferred from the bleacher directly to the drying compartment without further treatment.

EVAPORATING THE FRUIT.

When the fruit has been placed in the drying compartment of an evaporator, of whatever type it may be, it has reached the most critical stage in the whole process of evaporation, and it is here that the greatest care and skill are required to insure the best possible results.

Capacity of floor space and racks.—In the case of kiln evaporators, the sliced fruit is evenly spread on the floor to the depth of 4 to 6 inches. A kiln 20 feet square will hold the slices of 120 to 150 bushels of fresh fruit, depending upon the amount of waste in the apples and the exact depth to which they are spread on the floor.

If the fruit is in quarters or is dried whole it may be somewhat thicker on the floor, since in these forms it does not pack down so closely as the slices do and hence does not impede the circulation of hot air through it if the depth is somewhat increased.

In other types of evaporators where the fruit is handled on racks the slices are seldom placed much more than 1 inch in depth. A rack 4 feet square will hold from three-fourths of a bushel to a bushel.

The fruit is generally put on the floor of the kiln as fast as it is sliced, and the fire is started in the furnace below as soon as the floor is filled, or, in many cases, before it is entirely covered.

Oiling the floors and racks.—It is a common practice to treat the floor of kilns occasionally with tallow to prevent the fruit from sticking to it. This is done every few days, or as often as conditions appear to make it advisable. Sometimes a mixture of equal parts of tallow and boiled linseed oil is used for this purpose.

Another practice with the same end in view is to thoroughly scrub the floors as often as is necessary with water, using with it some one of the scouring soaps. This is preferred by some operators who claim that oil or tallow discolors the fruit.

At each filling of the racks, where these are used, the surface of the wire netting is lightly wiped over with a cloth moistened in lard. This prevents the fruit from sticking to the netting and keeps it clean.

Temperature maintained.—Little is actually known in regard to what temperatures give the most satisfactory results in evaporating fruit, though operators in an empirical way have arrived at certain practical conclusions.

Caldwell[1] states:

> In the kiln evaporator, at least 95 per cent of operators maintain a temperature of 155° to 165° for the first five or six hours after the kiln is filled. If the temperature is raised higher than the second figure named the cellular

[1] Caldwell, J. S. Evaporation of Apples. Wash. Agr. Exp. Sta. Bul. 131, 110 p. 24, fig. 1916.

structure of the fruit is destroyed by expansion of the contained vapor and serious loss of sugar by bleeding occurs; unless the temperature is kept up to this level the surfaces of the fruit become slimy and the subsequent drying is retarded. After the first five or six hours, some operators allow the temperature to go down to 130° or 135°, open the ventilators widely, and continue the drying by using large volumes of air at lower temperatures for 10 to 12 hours, after which the temperature is brought up to 175° to 180° and kept there until the drying is completed. Users of this method claim for it that it is economical of fuel—a claim which seems to be well established—and also that it makes a more springy, "lively" product, which resists exposure to unfavorable conditions much better than fruit dried with a uniform temperature. This second claim does not appear to be fully substantiated, and most operators carry the fruit through the whole process at a temperature of approximately 160°.

In the tunnel evaporator, the majority of operators maintain a temperature of 160° to 175° in the lower and hotter end of the tunnel, while the upper end will be 15 to 25 degrees cooler. Since the fruit is introduced at the upper end and gradually moved toward the hotter end, it begins to dry at 135° to 150° and is finished at the higher temperature. This is essentially what the operator of the kiln accomplishes by the first method described.

While the temperatures maintained in other types of evaporators evidently vary more or less, it is probable that the range is not very different from the extremes mentioned above, when the evaporators are properly operated.

Turning the fruit.—In order to prevent the fruit from burning and from sticking to the floor by remaining in contact with it too long and to insure the most uniform drying that is possible, the fruit, in the case of the kiln driers, is turned occasionally. The interval between turnings varies with different operators, with the condition of the fruit, and with the degree of heat which is maintained. Some operators do not turn the fruit until five hours have elapsed after the furnace has been started, while a more common practice is to make the first turning within two to three hours after the drying is begun, or even sooner. For the first five or six hours it is generally turned every two hours or so, and more frequently as the fruit becomes drier, until perhaps it may require turning every half hour when nearly dry.

The objects to be obtained by turning must be kept in mind and the fruit handled accordingly. It should be examined from time to time and turned often enough to prevent scorching or sticking and to insure uniform drying.

In the case of other types of evaporators in which the fruit is handled on racks or trays, no turning more than an occasional stirring of the fruit with the hand or with a small wooden paddle is required. Sometimes the relative positions of the racks are changed to make the drying more uniform. This is one reason why the fruit dried on trays is generally of rather better quality than that from kilns. The repeated turning on the kiln floor is likely to make the

fruit more or less "mussy," while in that which remains practically undisturbed on the racks the rings are maintained in better condition. The fruit also dries more quickly, and is often of better color than the kiln-evaporated product, and hence is more attractive in appearance.

The same general principles must be observed in tending the fruit where steam heat is used in place of direct hot air from furnaces.

Time required for drying.—The time necessary for drying fruit depends upon several factors. The more important are: Type of evaporator, depth to which fruit is spread, method of preparing (whether sliced, quartered, or whole), temperature maintained, conditions of the weather, and (to a certain extent) the construction of the evaporator.

The application of these several factors to the point in question readily follows. A good kiln evaporator should dry a floor of slices, other things being equal, in about 12 hours, 10 to 14 hours being the range of variation. Where the fruit is handled on racks, the time required is much shorter, but conditions are quite different from the kilns, as the fruit is seldom more than 1 or 2 inches thick on the racks. For slices, 5 hours is considered a reasonable time, with a range of 4 to 6 hours.

It is estimated that quarters will require from 18 to 24 hours in the average kiln, while the time for whole apples will range from 36 to 48 hours.

If the atmospheric conditions are heavy and damp, the drying is retarded. Under some conditions it is hardly possible to thoroughly dry the fruit. During windy weather also it is more difficult to regulate the heat, especially if the walls are poorly constructed, so that the draft of cold air into the furnace room can not be controlled. This applies especially to kilns heated by furnaces. It is claimed that steam-heated evaporators are less subject to the influence of climatic conditions.

When is the fruit dry?—Perhaps there is no step in the entire process that requires better trained judgment than the matter of determining when the fruit is sufficiently dried to meet the requirements. Like several other steps in the process, it is largely a matter of experience, though there are certain general features which are capable of being reduced to words.

The fruit should be so dry that when a handful of slices is pressed together firmly into a ball the slices will be "springy" enough to separate at once upon being released from the hand. In this condition there will be no fruit, or only an occasional piece, that has any visible moisture on the surface. In a slice of average dryness it should not be possible to press any free juice into view in a freshly made cross section of it. In general, the fruit, as it is handled, should feel soft and velvety and have a pliable texture. This is a critical stage,

since the slices may seem to possess these characteristics in the proper degree while warm, but after they are removed from the evaporator and have become cold they may be so dry as to rattle unless the removal has been very accurately timed.

The foregoing should represent as nearly as possible the average condition, but it can not be expected to be absolutely uniform throughout. Some slices—they should constitute only a very small percentage—will still plainly possess some of the juice of the apple; others—likewise, properly only a small proportion—will be entirely too dry, possibly dry enough to be brittle.

The curing or conditioning room.—When a quantity of fruit is considered dry enough it is removed from the kiln and put in a pile on the floor of the curing room. Every day or two the pile should be thoroughly shoveled over to make uniform the changes which take place. Thus managed the pile in a few days will become thoroughly homogeneous. The pieces that were too dry will have absorbed moisture, the superfluous moisture of other pieces will have disappeared, and the entire mass may be expected to reach the condition above described.

HANDLING THE WASTE.

In the usual grades of apples taken to the evaporator there are many specimens that are too small to pare or which for other reasons can not be profitably used in this way. In the case of some of the larger evaporators which are operated in connection with vinegar factories, these apples, as well as all parings and trimmings, are used for "vinegar stock," but in the smaller ones these portions are usually dried. It is generally estimated that about one-third as much space is required to dry the parings and trimmings as is demanded for the "white fruit."[1]

"Waste" and "chops" are generally bleached, but are seldom passed through the bleacher which is used for the white fruit. Where they are dried in kilns, which is usually the case, a common way of bleaching is to burn the sulphur in the furnace room after the stock has been spread on the floor.

It is generally estimated that the waste from a given quantity of apples will pay the cost of the fuel for evaporating that quantity of fruit; that is, putting it on a bushel basis, the waste from a bushel will pay for fuel to evaporate both the white fruit and the waste from that bushel. While in some instances, when the price of such stock is low, this estimate may be too high, it not infrequently happens that it more than pays for the fuel.

[1] "White fruit" is a general term used by operators and dealers to denote the grades used for culinary purposes, in distinction from "waste," which comprises the parings and trimmings, and "chops," which are composed of the apples that are too small and otherwise defective to pare.

WEIGHT OF EVAPORATED APPLES.

Some varieties of apples will make more evaporated stock to the bushel than others. The grade used also affects the amount, but an average weight—a frequent basis of estimates—is about 6½ pounds of white fruit and 3½ pounds of waste to a bushel of fresh fruit. When the apples are dried whole, without slicing, they will make from 1 to 2 pounds more to the bushel than when sliced.

PEACHES.

ECONOMIC CONSIDERATIONS.

At the present time an important economic factor enters into the general proposition of drying or evaporating peaches in the widely distributed peach-producing regions of the country.

For a number of years, which extended from the late seventies to the early nineties, large quantities of peaches were evaporated in Delaware and perhaps in some of the other older peach-growing regions. Twenty years or more ago one of the largest peach growers in the Fort Valley section of Georgia undertook to evaporate some of his fruit, but after operating a season or two the effort was abandoned as impracticable under existing conditions. For the past 25 years, however, practically no peaches have been evaporated for commercial purposes in this country outside of the State of California. The reasons for this are largely economic. The peach-growing regions in the humid parts of the country are located more advantageously, as a rule, than are the peach-growing sections of California, with regard to the large consuming centers for the fresh fruit. This fact, of course, has to do with the logical working out of the best methods of disposing of the crop in different regions.

It is commonly recognized, too, that the peaches which are largely dried in California contain less juice in the fresh state, and for this reason are better adapted for drying than the fruit grown in humid regions. Whether this is a matter of variety, culture, or the result of environmental conditions is unimportant in this connection.

Perhaps the most potent factors in the economics of the case, and especially at the present time, are relative cost of drying and relative selling price of the product. In all humid regions the cost of fuel must be added to the expense of operation, in comparison with drying in California, since in that State peaches are dried, with a few if any exceptions commercially, by exposure to the sun. The cost of handling may be more under California methods, but probably the difference is not great. As a fuel cost, roughly estimated, about 1 cord of wood or a ton of hard coal is required to produce a ton of dried fruit.

Whether in an earlier day the varieties available for drying constituted a factor favorable to some regions and adverse to others is unimportant now. The variety factor is fundamental at the present time. In California, the Muir and Lovell are planted on an extensive scale expressly for drying. These ripen in good sequence with each other and are yellow freestones with rather dry, fine-grained, firm flesh, characteristics which are essential in a good drying peach.

In the earlier day when peaches were being evaporated in the East, such sorts as Early Crawford, Foster, Oldmixon Free, Moore, Late Crawford, Stump, and others, were used. It is obvious that the dried product as a whole would lack the uniformity that is now demanded by the trade. However, within the past 25 years, the Elberta has come very largely to the fore in all humid peach-growing regions. So important is it, relatively, that in most of the peach-growing centers it is the only variety shipped in relatively large quantities for use in the fresh state.

While the Elberta is dried to a very limited extent in California, the quantity handled in this way is negligible compared with the Muir and Lovell. The Elberta has some characteristics of a good drying peach, but it may be questioned whether the dried fruit would be of sufficiently high grade and attractive enough in appearance to compete successfully with the dried fruit from the Pacific coast when placed on the market in large quantities. It follows, in view of the very extensive production of the Elberta in most peach-growing centers in the humid regions, in comparison with other sorts, that the great bulk of the fruit available for drying in those regions is of the Elberta variety. Under normal conditions the annual average of 30,000 tons, more or less, of dried peaches from California supplies the market demand. It appears evident, that should a large quantity of Elbertas from other sections be dried, new demands or new markets for the product would have to be developed if the growers who dry their fruit are to profit thereby. Possibly the abnormal conditions now prevailing throughout the entire world will create demands that will absorb new and unusual food supplies.

THE DETAILS OF DRYING.

The kiln type of evaporator, which as previously noted is largely used in drying apples, is not suited to peaches, the characteristics of the fruit being such that it can not be handled well in the large bulk that is necessary to make the use of a kiln economical. Any of the cabinet or tunnel types where the fruit is spread in a thin layer on trays may be used in evaporating peaches.

The fruit to be evaporated should be of a uniform degree of maturity and fully ripe, otherwise the finished product will lack uni-

formity. Immature fruit does not make a good dried product. Moreover, the rate of drying is governed in part by the size of the pieces; hence, it is an advantage if the fruit that is placed on any one tray is fairly uniform in size.

The first step in the actual preparation of the fruit is to split it open to remove the pit. This is done by cutting completely around the peach in the line of the suture with a sharp knife. The cut needs to be complete, since any tearing of the flesh will be apparent in the evaporated product, making it less attractive in appearance than it otherwise would be.

If the fruit is to be peeled, which it not the usual practice, the paring should be done before the fruit is cut open for the removal of the pit. Paring is done by hand, as a rule, when the practice is followed, sharp, straight-backed knives with blades 2½ to 3 inches long being satisfactory for this purpose. Paring machines have been designed for peeling peaches, but they do not appear to be much used.

After the pits are removed the fruit is treated to the fumes of burning sulphur in much the same manner that apples are treated and for the same purpose. The fruit should pass to the bleacher with the least possible delay after it is split open, in order to prevent discoloration. Because of the character of the fruit, however, it should not be handled in large bulk during the bleaching process, as is sometimes done with apples. On the other hand, the halved fruits should be handled in trays or boxes that are rather shallow. Trays having slatted bottoms, which allow the sulphur fumes to circulate freely, are to be preferred, doubtless, to those having solid board bottoms. It follows that a bleacher constructed in the form of a cabinet into which the trays containing the fruit may be placed (see illustration on title-page) should be used rather than one of the horizontal type shown in figure 7, where the fruit drops by gravity into bleachers and in a similar manner passes out at the opposite end. This treatment would bruise the pieces of peaches unduly, causing dark, unattractive spots to appear in the fruit when dry.

As previously implied, there is little definite experience in evaporating peaches by artificial heat on which specific directions or advice can be based. This applies emphatically to the details of bleaching. In the days of peach drying in the East, a half-hour's exposure to fairly dense fumes of sulphur was regarded by many operators as adequate for preparing a product that would be bright colored and attractive when finished.

Perhaps the safest guide that can be suggested is the one mentioned under the bleaching of apples on pages 25 and 26.

If it is found that the juice of the fruit in bleaching is being lost by dripping from the fruit, it will be wise to place each piece of fruit

carefully by hand in the bleaching trays with the cut surface or "cup" side uppermost. The juice will then collect in the cup, and if handled carefully it will evaporate in the drying of the fruit. The solids in the juice thus saved will add to the flavor, quality, and weight of the dried product.

The bleaching completed, the fruit is ready to be placed in the evaporator. The fruit should be spread on the trays in a single layer, one piece only in depth and preferably with the cut surface or the cup side uppermost, and in this condition it goes into the evaporator.

Comparatively little is known definitely in regard to the best temperatures for evaporating peaches. The general practice in drying apples, given on page 27 is probably applicable also to peaches.

The length of time required to dry the fruit will vary with the equipment, the efficiency with which it is managed, the weather conditions at the time evaporation is being carried on, probably to some extent the weather conditions during the development of the fruit, and more especially the weather conditions during the few weeks immediately prior to picking. The variety is also a very definite factor in the time required for drying. Beers Smock and other comparatively dry-fleshed sorts may be in condition for removing in 5 to 7 hours' time; others, under the same conditions of operation, in 6 to 8 hours, while very juicy varieties may need to remain in the evaporator from 12 to 15 hours. Obviously, however, such sorts as the latter are not desirable for drying, unless they possess other qualities which give them some peculiar value.

After the fruit has been in the evaporator for a time and is partly dry it should be turned over to promote uniformity of drying. Turning may need to be repeated once or twice before the fruit is ready to remove from the trays.

Good judgment, which develops only with experience, is necessary to determine just when the fruit is in a proper state of dryness to be withdrawn from the evaporator. In general, the fruit should possess the same physical properties as apples when evaporated. It should not be possible to bring free moisture to the surface upon squeezing a freshly cut surface tightly between the fingers; it should have a velvety, springy, pliable texture, and when a double handful of the fruit is tightly pressed together the pieces should immediately fall apart when the hands are released.

When the fruit comes from the evaporator, as in the case of apples, there will be some pieces that obviously contain too much moisture; others will be so dry and hard that they will rattle when they are handled. By placing them in a pile of considerable size (fig. 14) and working them over several times during a period of a week or two, as is done with apples (see p. 30) the entire lot will become uniform in its moisture content. When this stage is reached han-

dling with a view to packing is the next step. This operation, however, does not require consideration in the present connection. The curing or conditioning room should be scrupulously clean and fully protected against insects of all kinds.

PEARS.

The drying or evaporation of pears in the humid regions has not received sufficient attention to establish any definite methods or rules of practice. Dried pears form one of the minor products in the dried-fruit industry of California, where the drying is very largely by exposure to the sun rather than through the use of artificial heat.

Usually the fruit is cut lengthwise into halves, the stem and calyx removed, but the core left in. If the fruit is very large, it may be quartered or cut into other smaller sections to facilitate drying.

Bleaching is necessary, as with apples and peaches, in order to secure an attractive-looking dried product. For equally good results rather more bleaching seems to be needed than with the other fruits named. The same general qualities described in connection with apples and peaches will indicate when a lot of fruit is ready to be taken from the evaporator, and upon removal it is handled in the same way.

CHERRIES.

Cherries occupy very much the same place as pears, so far as commercial drying in humid regions is concerned, and they are hardly more important in those regions where sun drying prevails. However, both sweet and sour cherries are dried by artificial heat as well as in the sun to a limited extent.

The fruit may be pitted or not before drying, but the best product is made when pitting precedes drying, though of course large quantities of juice are lost in the operation unless some provision is made for saving and utilizing it in some way. No bleaching is necessary. In other respects they may be handled much as raspberries are handled. The evaporation of this fruit is discussed on a later page (see p. 39.)

PRUNES.

The question "What is a prune?" is frequently asked. The answer is simple. A prune is merely a plum having certain varietal qualities not possessed by other plums. The final, distinguishing quality or character is ability to dry without fermenting with the pit still remaining in the fruit. If a plum can not be dried without fermenting unless the pit is removed (as is true of the great majority of varieties) it is not a prune. Therefore it may be said that all prunes are plums, but not all plums are prunes. As a matter of fact, all of

the prunes of commercial importance belong to the *domestica* or European group of plums. None of the native or Japanese varieties are dried for market purposes, though there are certain native plums which are used locally in this way to a limited extent.

The commercial drying of prunes in this country is carried on in the States of Oregon and California, and to some extent in certain localities in Washington. The quantity dried in other States is so small as to be negligible. In Oregon and Washington the drying is done in evaporators, while in California sun drying is largely practiced, though evaporators are also used more or less in some sections. The practices followed in sun drying are described on a later page.

Most of the dried prunes offered to the trade consist of two varieties—the Italian, grown largely in Oregon and Washington, and the Agen, or, as it is much more commonly called, the *French* or *Petite*, grown in California. A few other varieties are dried in small quantities but they are unimportant as compared with the ones named.

Prunes for drying, like other fruits, should be fully ripe. The common practice is to permit them to remain on the trees until they drop of their own accord or will fall with a very light tapping of the branches with poles. The fruit is then gathered from the ground and placed in lug boxes or other convenient receptacles and taken to the evaporator. Sometimes the fruit that drops naturally is picked up at three or four different times, and then poles are used to complete the harvest.

While the details of handling the fruit at the evaporator vary considerably with different operators, a composite course is about as follows:

Dipping the fruit.—The fruit is dipped in a lye solution, the object of which is to cut the bloom from the fruit and to produce a very fine checking of the skin. If this is not done, the moisture in the fruit can not escape readily and the fruit, in drying, will not assume the shrunken condition that is desirable. Instead, many "frogs"[1] or "chocolates," as they are variously called, i. e., fruits which do not assume the desired shrunken condition, will result. Such fruits have to be graded out and are worthless, or nearly so, as dried prunes.

The lye solution is made by dissolving ordinary high-grade caustic soda or caustic potash in water. The strength at which it is used varies from a pound in 10 or 12 gallons of water to a pound in 25 or

[1] The terms "bloaters," "frogs," and "chocolates" are variously used to denote fruits that do not dry properly, but remain plump and retain certain other undesirable characteristics. "Bloaters" (California Exp. Sta. Bul. 114) have been designated as large, fully ripe fruits which ferment slightly in drying, producing a small amount of gas which prevents them from shrinking. "Frogs" are usually small, poorly developed fruits which for some reason will not respond properly to the lye solution. The skin does not become checked, and they do not dry properly. If a tree is very heavily overloaded and the fruit correspondingly small and poorly developed, much of the fruit from it is likely to "frog" when dried.

30 gallons of water, depending upon the variety (some requiring a stronger solution than others to accomplish the end in view), the temperature at which the solution is maintained, the length of time the fruit is immersed, etc.

Ordinarily, the lye solution is maintained at the boiling point, the tank in which it is contained being placed over a furnace or supplied with steam coils in such a manner as to maintain the desired temperature.

Where the solution is maintained at this high temperature, it is necessary to hold the fruit in the solution only a few seconds, though the time varies to some extent with different varieties. The operator soon learns to determine by the appearance of the fruit the necessary length of time under the temperature and other conditions that are being maintained. If the solution is too strong, or if the fruit is immersed for too great a length of time, the slight checks in the skin will become definite cracks in the fruit. This should be avoided, as fruits which are definitely cracked will not make a desirable dried product.

Some operators pass the fruit through a bath of clear water after it comes from the lye solution; others consider this a nonessential. In addition to the dipping, the fruit, in some instances, is passed over a perforator, which in brief is an inclined plane provided with very small pin points, in order to slightly puncture the skin of the fruits as they pass over it. The pricking of the skin in this way serves the same purpose as the checking of the skin mentioned above in connection with the dipping. Where the perforator is used it is not necessary to carry the dipping quite as far as where it is not used, though the lye solution should completely remove the bloom from the fruit.

At this stage in the procedure the fruit is commonly graded as to size, in order that when spread on the trays the fruit on each tray may be uniform in size; otherwise, there would be a wide variation in the drying of the fruit, because the smaller prunes dry more quickly than the larger ones.

Combination machines are on the market which include equipment for dipping, washing, perforating, and sizing the fruit, and in which the fruit is automatically passed from one operation to the next. Where extensive operations are concerned, such an equipment is essential, but smaller, more simple equipment involving all hand-work serves the purpose very well for small-scale activities.

The fruit is then spread on trays or racks made usually with wooden frames and bottoms of galvanized wire netting, having about a $\frac{1}{4}$-inch mesh. A single layer of fruit only should be placed on the trays. It is then ready to be placed in the evaporator.

Handling in the evaporator.—It is obvious from the foregoing that an evaporator of the kiln type is not suitable for use in drying prunes. Any of the types in which the fruit is placed in thin layers on trays or racks as described above can be used. As a matter of fact, in California and Oregon the tunnel type is largely used. Figure 15 shows the exterior of an evaporator in Oregon. The dipper and other equipment used in preparing the fruit for drying is housed in the annex with a shed roof.

Considerable must be left to the operator's judgment with regard to the temperature at which the evaporator should be maintained. If it is too high in the beginning there is said to be danger of the

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FIG. 15.—Exterior view of a prune evaporator in Oregon. The dipper and sizer are placed in the annex with shed roof. The compartments in which the fruit is dried are in the main part of the building.

fruits bursting open. As nearly as can be stated in definite terms it is safe to start with a temperature of 120° to 130° F., gradually raising it until the fruit is finished at 170° to 180° F.

As with other fruits, the time required in which to dry prunes varies with conditions, but from 24 to 30 hours is a conservative average. During the period when the fruit is in the evaporator it should be turned several times for the purpose of insuring as far as possible uniform drying.

The fruit is dry when the skin is well shrunken in the manner familiar to all users of prunes. The texture should then be firm but springy and pliable enough to yield readily when pressed in

the hand. The drying should not continue until the individual fruits rattle as they are brought in contact with one another in handling. It is true, however, that when the bulk of the fruit has reached the proper degree of dryness some specimens will be too dry while others will contain an excess of moisture, as is the case with other fruits. The condition is equalized in the same manner as with apples and peaches, by placing the prunes in a pile when they come from the evaporator, and working them over from time to time until uniformity of product is reached. This may require from several days to two or three weeks.

Instead of piling the fruit in bulk, it may be put in boxes of convenient capacity to handle and poured from one to another every day for a time while the fruit is curing or conditioning. Before the fruit is conditioned, however, the "bloaters" and "frogs" should be removed.

In drying, prunes shrink in weight on an average about three to one, i. e., about 3 pounds of fresh fruit are required to make 1 pound of the dried product.

SMALL FRUITS.

The small fruits are evaporated or dried to a limited extent only, with the exception of the Logan blackberry, which is a commercial factor in the fruit industry of the Pacific coast, and black raspberries, which are dried on a more or less extensive scale, principally in New York. Other small fruits, such as red raspberries, blackberries, strawberries, and blueberries, and perhaps still others, are dried sometimes for home use, but they are rarely seen in the market. These fruits may be dried by essentially the same methods as the more important ones above mentioned. These methods are briefly described here.

BLACK RASPBERRIES.[1]

In some sections, the kiln type of evaporator is largely used in drying raspberries. The ones built in recent years have been constructed in general according to the plans described and illustrated in the first part of this bulletin, but the older evaporators do not have the hopper above the furnace, the heat instead passing through a series of pipes suspended about 2 feet beneath the floor of the kiln. However, a good many evaporators of the tunnel and other types are still being used, in which the fruit is handled on racks or trays with galvanized-wire netting bottoms.

Before the fruit is placed in the kiln, the floor is usually covered with muslin, burlap, or some other kind of loosely woven fabric,

[1] The methods here given are adapted in part from Farmers' Bulletin No. 213, entitled "Raspberries"; in part from Cornell Univ. Agr. Exp. Sta. Bul. No. 100, entitled "Evaporated Raspberries"; and in part from notes supplied by Mr. George M. Darrow.

for the purpose of preventing the fruit from dropping through the spaces between the strips of which the floor is made, or sometimes galvanized-wire netting with ⅛-inch mesh is used instead of a fabric.

As with all other fruits, raspberries for drying should be fully ripe. Much of the fruit is harvested by batting—a method whereby a wire hook is used to draw the canes into the desired position, allowing them to be lightly beaten with a wooden paddle which knocks the fruit into a device so arranged as to readily catch it as it drops. An expert hand picker under favorable conditions will hardly average more than 125 quarts a day, while in harvesting by the batting method 7½ or 8 bushels is a fair average.

The manner of operating an evaporator in which raspberries are being dried is substantially the same as when other fruits are being handled. Where an evaporator of the kiln type is used, the fruit is spread on the floor from 4 to 6 or 7 inches deep, depending largely on the variety. Firm berries, such as the Ohio, can be placed considerably deeper than the softer more juicy sorts such as the Farmer. Where evaporators other than those of the kiln type are used the raspberries are spread in a thin layer on the trays, a tray 4 feet square carrying about 15 or 16 quarts of fruit. The temperatures usually maintained while the fruit is drying, so far as known, are about the same as for other fruits. It should probably rarely go above 175° F. or 180° F., though Bailey refers to trays going into a stack or tower type of drier with the temperature at the bottom as high as 200° F. If too high, it is obvious that the fruit will be cooked rather than dried. The highest temperature is maintained during the first hours of the drying and is permitted to drop somewhat toward the end.

As it begins to dry, the fruit passes through a soft stage, which, however, lasts for only a comparatively short time. After this stage is passed and as soon as it can be done without mashing the individual fruits, the contents of each tray should be turned over occasionally to insure as far as possible uniformity in drying. Turning may be done with a small wooden-toothed rake or wooden scoop.

The length of time required to hold the fruit in the evaporator depends upon the same general factors that determine the time for other fruits—the weather conditions, type and management of the evaporator, and the variety of the berry. Some varieties dry quicker than others under the same conditions. Then, too, first pickings of the fruit frequently contain more moisture; hence, they require a longer time in which to dry than the later ones, particularly if the end of the berry season is accompanied by a drought, as is frequently the case.

Bailey[1] gives the time required for drying fruit on trays at from 4 to 5 hours for the Ohio variety, noting that it dries more quickly than some other sorts.

Under some conditions, the rate of drying and consequently the length of time the fruit remains in the evaporator, is made a matter of convenience to some extent. For example, the conditions in one region where large quantities of black raspberries are dried are such that it is convenient to place the fruit which is harvested during the day on the kiln floor late in the afternoon. The furnace is at once started, running the heat at once as high as the operator thinks the fruit will stand. The fruit is turned early the next morning and again in the middle of the forenoon, and by 3 or 4 o'clock in the afternoon it is ready to go to the curing room, the heat having been allowed to subside somewhat during the latter portion of the time. Upon the removal of the fruit, the kiln is again ready for another "run" with the fruit harvested during the day. While it might be possible to dry the fruit in a shorter period of time, this program is a convenient one under some conditions.

It is estimated that a ton of hard coal will dry about a ton of berries, but the quantity varies from half a ton to 2 tons of coal to a ton of fruit, depending on the variety, condition of the fruit, and other factors.

Experience alone will enable the operator to tell with certainty when the fruit is dry enough to be removed from the evaporator. When this stage is reached, some of the fruit will be dry enough to rattle; there will also be fruits (the proportion should be very small) obviously containing too much moisture. The bulk of the fruit should be of such a texture that it will stick to the hand somewhat if squeezed tightly, while yet the individual fruits can not be forced into a mushy condition; or another test may be to carry the drying as far as possible without reaching the point where the fruit will rattle as it is handled over on the trays. The fruit is then removed from the trays and placed in bulk on a smooth, clean, tight floor where it is handled over each day with a scoop or other suitable implement for a period of perhaps two or three weeks. During this time the fruit is becoming uniform throughout with regard to moisture, and the drying progresses to the point where the fruit can be stored safely without danger of spoiling.

The curing room should be an airy, well-ventilated place. The fruit, if handled in bulk, may be placed in piles from 6 to 18 inches deep. However, some advantages are claimed for the method of handling the fruit in boxes having a capacity of a bushel or so, dur-

[1] Bailey, L. H. Evaporated raspberries in western New York. N. Y. (Cornell) Agr. Exp. Sta. Bul. 100, p. 439–502, fig. 105–139. 1895.

ing the period of curing. In this way the fruit can be aerated thoroughly by pouring the contents of one box into another.

The variety, condition of the fruit, and other factors influence the shrinkage in drying. Bailey states that it requires, on an average, a little over 3 quarts or about 4 pounds of black raspberries to make 1 pound of the dried product. In a rainy season it may require 4 quarts to make a pound of dried fruit, while near the end of the season, when the berries are small, 2 quarts of fresh fruit will yield a pound of the dried product. Other estimates put the shrinkage at about 2½ pounds of the Ohio variety to a pound of dried fruit, while it requires about 3½ pounds of the Farmer for 1 pound of the dried product. Four or five quarts of red raspberries are required for a pound of evaporated fruit. Red raspberries, however, are rarely dried.[1]

LOGAN RASPBERRIES.[2]

The Logan blackberry is grown extensively only in the Pacific Coast States, and naturally it is in those States that particular attention has been given to the utilization of the fruit. Lewis and Brown, of the Oregon Experiment Station,[3] have reported results of investigations in evaporating it. In that State both stack (or tower) and tunnel types of evaporators have been used in drying the berry, with preference for the latter if the tunnel is not too long. These are the same evaporators that are used in many instances in drying prunes. There has been a tendency to increase the length of the tunnel in building new evaporators, in the belief that their capacity was thus being increased. It has been determined, however, that with an undue length the rapidity of air circulation is retarded so that in effect the rate of drying may be decreased to such an extent that a tunnel of a given length may actually turn out more dried fruit than one otherwise the same except that it is longer. The efficiency of an evaporator depends very much upon the rate of movement of the heated air over the fruit.

Lewis and Brown state that the length of tunnels used varies from 20 to 34 feet without stating the optimum length for efficiency, though from inference it would appear that the shorter ones have given the best results.

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[1] Bailey, L. H. Op. cit., p. 460.

[2] The term "Loganberry" or merely "Logan" has been quite habitually applied to this fruit in the past, but from recent investigations it appears that it is in all respects a blackberry, except that the fruit happens to be red in color, though when very ripe the color is quite dark.

[3] Lewis, C. I. and Brown, F. R. Loganberry by-products. Oreg. Agr. Exp. Sta. Bul. 117, 32 p., 9 fig. 1914.

In operating the tunnel evaporators used in Oregon, the fruit is placed in the tunnel at the upper end, which is remote from the furnace. The temperature here is usually about 100° F. As it is pushed downward the heat increases, and at the point over the fire box, where the trays are removed when the fruit is dry, the usual temperature is about 160° F. It was observed, however, that the fruit lost moisture only very slowly for some time after it was put in the tunnel, where the temperature was only 100° F. Investigations in regard to the efficiency of different temperatures indicated that the best results follow when the evaporators were so managed that the fruit was inserted at a temperature of 130° F. and finished at about 150° F., provided a good circulation of air through the tunnel was maintained. This could not be done satisfactorily in the longer tunnels.

The time required to dry the fruit varied from an average of about 33 hours, with the temperatures maintained as at first stated with the fruit inserted at 100° F., to about 17½ hours, as an average where the fruit was inserted at the higher temperature. As these berries are considerably larger and more juicy than black raspberries, it is readily understood why they do not dry as quickly as the latter.

The manner in which Logan blackberries are handled will affect the weight of the dried product, but on an average 1 pound of dried fruit is made from 4½ to 5½ pounds of fresh fruit.

It is advised to remove the fruit from the evaporator while it is still hot, otherwise the berries will stick to the trays. They are placed on a cooling table when removed from the trays. When cool, the fruit is stored in sacks or in bulk in a clean, darkened room. It is necessary to protect the fruit very promptly, either by bagging or putting it where it is dark, from certain moths which might otherwise lay their eggs in it.

Lewis and Brown say nothing about curing the fruit as is described for raspberries, though it would seem to be necessary. Otherwise the general details of drying do not differ fundamentally from those that give good results with raspberries.

OTHER SMALL FRUITS.

Strawberries, blackberries, blueberries, huckleberries, and other small fruits are sometimes dried in very limited quantities. No special mention of details is needed in this connection, since the methods already described for black raspberries and Logan blackberries may be used in handling other fruits of similar character.

THE SUN DRYING OF FRUITS.

From a commercial standpoint, fruits are dried by exposure to the sun but little in the United States outside of California. In that

State nearly all of the dried fruit, which amounts annually in value to hundreds of thousands of dollars, is sun dried. The reason for this difference in methods is plain. The dry atmosphere which characterizes the climate of California, the clear continuous sunshine, the absence of dew (at least in many sections), and the comparative freedom from rain during the period when the fruits are ripening are all very favorable for sun drying. This method is practicable wherever similar climatic conditions prevail.

Sun drying, while not impossible in the humid sections, is impracticable, as a rule, except perhaps on a small scale. The amount of moisture in the air, the heavy dews, and the frequent rains of the humid regions operate against sun drying, just as the absence of these moisture factors favors it in the arid regions.

The extent of the dried-fruit industry of California (excluding among the important fruits figs and raisins) is indicated by the statistics in Table I.

TABLE I.—*Approximate quantity of certain fruits dried in California during the years 1909 to 1916, inclusive.*[1]

Kind of fruit.	Average annual product of dried fruit.	Extremes.		
		Minimum.	Maximum.	Year.
	Tons.	*Tons.*	*Tons.*	
Apples	3,400	1,900	4,500	1913 1916
Apricots	15,000	10,500	20,000	1913 1912
Peaches	26,000	14,000	37,000	1911 1914
Prunes	62,200	40,000	102,500	1910 1912
Pears and other fruits [2]	2,700	2,000	3,750	1913 1911

[1] Deductions made from figures published in the annual review number of the California Fruit News for 1914 and 1916. The figures for 1916, however, are estimates on the basis of the anticipated output.

[2] Data only for the years 1911 to 1916, inclusive; the minimum stated for 1913 was approximately the same as in 1915.

The average production of dried peaches for the 5-year period, 1912 to 1916, was about 30,000 tons, a considerable increase over the average for the past eight years as given in Table I.

The production of dried pears is not reported separately, but it is very small compared with the fruits specifically named. Some 1,500 tons, more or less, evidently represents a general average.

While the methods of drying fruit in the sun as practiced in California find but small application elsewhere, a good many requests for information relative thereto are received at the Department of Agriculture. For this reason a concise account of the sun drying of fruits is given here. Besides, in many seasons in humid regions, there are periods of drought of considerable length when little or

no rain falls. During these periods drying fruit in the sun might be possible on a small scale if advantage were taken of the best conditions, if facilities for protecting the fruit from the dew and from possible rains were available.

EQUIPMENT FOR SUN DRYING.

Where operations are conducted on a commercial scale, a suitable drying yard is essential. This is fundamentally an open plat of ground where the fruit is exposed to the sun. It is very important that it be located where it will be as free as possible from dust, and the surface of the yard itself should be maintained with the seriousness of the dust factor in mind. Sometimes it is devoted to alfalfa during the portion of the year when it is not in use for drying fruit, the alfalfa being cut immediately before the drying season begins.

In most yards the trays on which the fruit is spread are placed directly on the ground. Considerable is gained in some respects,

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FIG. 16.—An open shed in California, where peaches, prunes, and other fruits are prepared for drying in the sun. (Photographed Aug. 25, 1913.)

however, if 2 by 4 timbers are put down at the proper distances apart to receive the trays, thus holding the latter slightly off the ground when the fruit is exposed for drying.

An open shed of rather cheap construction is generally provided in which the fruit is prepared. Such a shed is shown in figure 16.

An adequate supply of trays on which to spread the fruit is a primary essential. The trays represent in value a very considerable proportion of the cost of equipment, especially where large-scale operations are conducted. Trays stacked awaiting use are shown in figure 16. They are made of various kinds of lumber, but pine or spruce is generally considered preferable, though redwood is sometimes used. Unless kept very clean, however, the latter is said to stain light-colored fruits. The dimensions of the trays vary; 3 by 8 feet, 2½ by 8 feet, and 3 by 6 feet are sizes not uncommon. The bottoms are made of boards half an inch thick; the sides are of

strips 1 by 2 inches, with pieces of the same material placed across the ends of the trays. If the side pieces extend about 4 inches beyond the ends of the trays, convenient handles for use in moving them about are thus easily provided.

Since most of the fruit is treated to the fumes of burning sulphur before it is exposed to the sun, in order to prevent its turning dark while drying, as well as for certain other effects, a suitable sulphuring house is essential. Figures 17 and 18 show the general features of structures for this purpose. Figure 17 is a sulphuring house which has four compartments. The trays are stacked on double trucks, as seen in the foreground, and the topmost truck, with its load of trays, is run into a compartment. From 18 to 25 trays are commonly put in a stack, with the end of each tray overlapping 3 or 4 inches, alternately, the one below, in order to provide free circulation of the fumes between the trays. If piled too high, there is danger of tipping the upper trays in removing them so as to cause the pieces of fruit to slide about, and in case of peaches and apricots of spilling the juice that during the sulphuring collects in the cup whence the pit was removed.

Sulphuring houses are variously built. That they be practically air-tight is a primary essential. This is secured by using tongue-and-groove material, boards and battens, or building paper, as individual needs and preferences dictate. Plain or corrugated sheet-metal material should not enter into the construction. The size of the compartments should be such that the trays stacked on a truck, as previously described, can be readily moved into them.

Another type of sulphuring house consists of a tightly constructed box of such dimensions that it will fit over a stack of trays on a car such as is described above. Such a box is less expensive to construct than a sulphuring house, and where the operations are on a limited scale it serves the purpose satisfactorily.

A sulphuring box may be swung by a rope from an overhead frame in such a manner that it can be raised and lowered into position with the rope rather than by hand. After being placed over a stack of trays and the proper supply of sulphur put in position and ignited, the soil should be banked up a little about the sides where they come in contact with the ground, to prevent the escape of the sulphur fumes. An adjustable air vent at the bottom and one at the top may be necessary in order to provide a slight draft until the sulphur gets fairly to burning, and then the vents can usually be closed.

If the trays are handled on trucks as shown in figure 17, as is usually the case in large yards, it follows that suitable tracks connecting the sulphuring house and the drying yard with the shed where the fruit is prepared is an important item of equipment. Parts of tracks may be seen in figures 17 and 18.

A supply of straight-backed knives with blades about 2½ to 3 inches in length, for use in cutting open such fruits as peaches and apricots for the removal of the pits, is necessary; also lug boxes or other kinds of receptacles in which the fruit is handled. Other minor articles of equipment may be needed from time to time, but those named are the important essentials for handling most kinds of fruit that are dried, other than prunes. Where prunes are concerned equipment for dipping the fruit and for perforating and grading it should receive attention. Suitable supplies of high-grade sulphur and a well-tested brand of concentrated lye for use in dipping prunes should be provided in advance of the drying season.

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FIG. 17.—A 4-compartment sulphuring house in California, showing the trucks used in conveying the trays from the cutting shed to the house, sections of the rails over which they run, and lug boxes at the left. (Photographed Aug. 25, 1913.)

DETAILS OF SUN DRYING.

It should be observed that many of the details of the drying of fruit in the sun can be acquired only by actual experience. The making of a high-grade product, however, depends upon the attention which the details receive.

Most of the operations will be considered under the different fruits, but the use of the sulphuring house may be described in this connection, since its operation, in principle, is the same for all fruits that are treated to the fumes of burning sulphur. The details vary only as the needs of different fruits may require. However, there is no uniformity of opinion or practice among the operators as to what treatment gives the best results with different fruits. Details differ widely, especially as concerns the amount of sulphur used per

given unit of space and the length of time the fruit is subjected to the sulphur fumes. Moreover, there is a difference in varieties, as well as in the degree of maturity of the fruit in the way in which it takes the sulphur fumes. It is therefore necessary to treat some lots of fruit longer than others to accomplish the desired results.

The fruit is subjected to the fumes of burning sulphur for various reasons: It prevents it from turning a dark, unattractive color while drying; it appears to have a definite influence on the readiness with which the fruit parts with its moisture content, sulphured fruit drying much more quickly and with a better texture than unsulphured

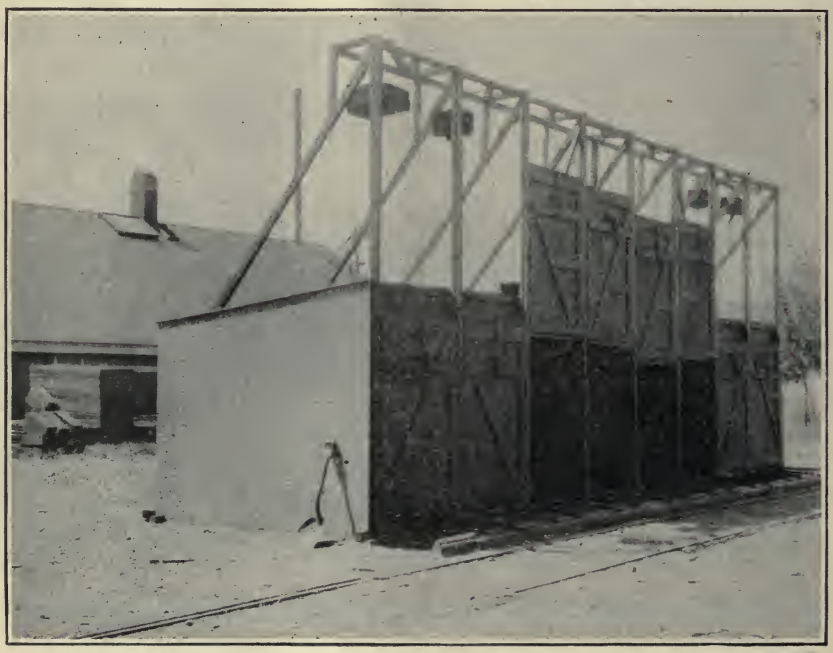

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FIG. 18.—A battery of sulphuring compartments in California, a type of house considerably used where large-scale drying operations are carried on. A section of the rails which connect these compartments with the cutting shed is also shown. (Photographed in 1913.)

fruit; with some fruits it is said to prevent souring in the early stages of drying; it also doubtless gives a certain amount of protection against insect injury while the fruit is exposed for drying.

A somewhat composite practice as to procedure is as follows: A stack of trays is placed in a compartment of the sulphuring house. A charge of sulphur (either the common flowers of sulphur or stick brimstone) is put in place, which is usually on the ground under the trays and near the door. Almost any metal pan or shallow crock serves to hold the burning sulphur, or a spot in the ground sligthly hollowed out will do. A few live coals, burning chips, or almost

any other substance that will burn slowly at first is placed in the receptacle, and then the sulphur is put on top of the burning substance, whatever it may be. This will ignite the sulphur, which when once started will continue to burn, usually without difficulty. The requisite amount of sulphur for the charge is sometimes placed on a piece of paper that burns readily and the edge of the paper lighted. This in turn ignites the sulphur.

The door of the compartment is then tightly closed. If constructed so that it is practically air-tight it may be necessary to provide small vents—one in the door near the bottom, the other toward the top of the compartment—which can be opened and closed at will, in order to provide sufficient oxygen to insure the burning of the sul-

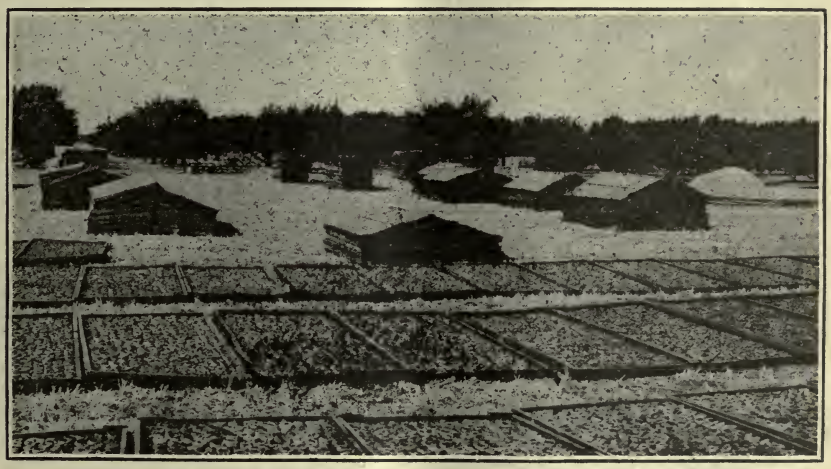

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FIG. 19.—A section of a drying yard in California, showing trays of Lovell peaches spread out for drying. The fruit is placed in a single layer with the cut surface or cup side uppermost. In the background, trays containing fruit that is nearly dry are stacked for finishing off. Stacks of trays awaiting use are also to be seen. (Photographed Aug. 25, 1913.)

phur. When the burning is once fairly started, however, the vents can usually be closed. Only high grades of commercial flowers of sulphur or stick brimstone should be used in suplphuring fruit.

In the sulphuring of fruits there is always a tendency to continue the treatment too long. While a full working knowledge of when to stop is learned only by experience, the statement may be put rather dogmatically that the fruit should be treated only for the shortest period of time possible and yet accomplish in a satisfactory degree the ends for which the treatment is given. Excessive sulphuring not only may injure the flavor, but it may result in the fruit absorbing and retaining an undue amount of sulphur dioxid. (See pages 59 and 60, under "Laws relating to evaporated and dried fruits.")

If showers occur while the fruit is exposed in the drying yard, it is of the greatest importance to protect the fruit against getting wet. To do this the trays are usually stacked as shown in the background in figure 19, except that they are sometimes overlapped more than the illustration shows, thus giving a steeper slope to the trays. An empty tray, or more if needed, is placed bottom side up on top of each section of the stack. If fruit becomes wet, as from a shower, while it is drying, it never finishes into as high-grade product as it otherwise would.

The fruit in all cases should be fully ripe, but not mushy. The condition commonly termed "eating ripe" indicates a suitable degree of maturity. If overripe, the individual pieces will not retain their shape; if underripe, the dried product will be poor in flavor, appearance, and texture. Moreover, a dried product of high commercial grade can not be made from cull fruit. While such fruit may produce a perfectly wholesome product when dried and its use in this way may often provide a satisfactory means of disposing of fruit that can not be marketed well in the fresh state, the producer should not expect to receive as high prices for it as for the product of the best grades of fresh fruit.

In California, many peach orchards and to some extent apricot and other orchards are planted for the specific purpose of producing fruit for drying, and most prunes that are dried in the Pacific Coast States represent the entire crop—not the culls from fruit otherwise marketed.

A large part of the evaporated apples put on the market are made from low-grade fruit, but in those regions where most of the evaporated apples are manufactured the grade of the seasonal output is the highest in those years when the crop is so abundant that low prices for the fresh fruit prevail and correspondingly large quantities of high-grade fruit go to the evaporators; or, in some cases, in years of small crops, where the cost of hand picking the fruit is relatively very large (because of its being scattered over the trees) the fruit is knocked off with poles and taken to the evaporator.

The details of sun drying different fruits are given in the following pages. The descriptions are based on California practices, since it is in that State only that fruit is dried in the sun on a large commercial scale. Liberal use of information contained in bulletins, the current horticultural press, and other publications has been made in preparing these notes, supplemented by limited personal observations.

PEACHES.

In California, the chief varieties used for drying are the Muir and Lovell. These are yellow, freestone peaches with comparatively

dry, firm flesh—all important characteristics in a good drying variety. White-fleshed varieties are not often dried, as the market prefers yellow fruit.

To insure full ripeness and a uniform degree of maturity of the fruit the trees are usually picked over several times, as when harvesting for shipment in the fresh state.

In preparing the fruit for drying the peaches are split open in the manner described on page 33, and the pieces are then spread on the trays in a single, uniform layer as shown in figure 19.

Few peaches dried in California are peeled, although there is apparently a growing tendency to peel the fruit before drying. Some attempt has been made to construct a machine which will pare the fruit satisfactorily, but no machine designed for this purpose is now in general use. Some hand paring is done with knives, and a hand-paring machine is obtainable. With some varieties the skin may be removed without much difficulty when the fruit has been treated to sulphur fumes. If the skin is to be removed following the sulphuring, each individual piece is picked up after removal from the sulphuring house and with a slight manipulation with the fingers the skin is slipped off. The pieces are then arranged on trays the same as those that are not peeled.

The trays are then stacked and placed in a sulphuring compartment in the manner described on page 33. The fruit should be placed in the sulphur fumes with the least possible delay after it is cut open. Otherwise the cut surface will discolor, and though the fumes will partially restore the natural appearance it is not likely to look so attractive as when no discoloration occurs.

Little uniformity of practice is noted among the different operators in regard to the sulphuring of peaches. Perhaps a pound of sulphur to a compartment of 250 cubic feet of space, with an exposure to the fumes for two to three hours is a fair average of the treatments given; in some cases, three or four times as much sulphur is used, though apparently not by conservative operators. If a compartment is charged at night, the fruit is sometimes left until morning; but if the compartment is tightly constructed such a long treatment is likely to be excessive. As may be noted, a much heavier sulphur treatment is given when the fruit is to be sun dried than when it is placed in an evaporator. This appears to be necessary on account of the long exposure to the air in sun drying. In handling the trays at this stage, it is important that they be kept nearly level, since during the sulphuring the cups become partly filled with juice. In drying, this juice is reabsorbed or evaporated, thereby improving the flavor and quality of the dried product over what it would be if the juice was lost. The solids carried in the juice also add some weight. After sulphuring, the fruit is ready to

be taken to the drying yard and exposed to the sun. The manner in which this is done is shown in figure 19.

The length of time it is necessary to expose the fruit to the sun varies with the size of the pieces, the season, the locality, the weather conditions, and other influences. From six to eight days is perhaps an average length of time. After the juice has evaporated and the cut surface of the fruit has become well dried, the pieces should be turned over, to insure, as far as possible, uniformity in the progress of drying. Possibly turning two or more times may be desirable in some cases. Within this period of six or more days under reasonably favorable conditions much of the moisture in the fruit will have passed off and the individual pieces of fruit considerably reduced in size. Some pieces will be much drier than others, and toward the end of the drying period the fruit should be sorted and graded according to its varying degrees of dryness. On account of the shrinkage in the size of the pieces, the number of trays required at this stage of the drying can be considerably reduced by combining the contents of different trays.

The trays are then stacked as shown in the background in figure 19, being placed endwise to the prevailing wind if there is preference in this respect. In this position they are allowed to remain until the fruit is thoroughly dry. This may require a period of two or three days or longer, depending on conditions. As a rule, the earlier the trays are stacked in the drying process after the fruit has lost enough of its moisture to keep in that position the better the quality of the product when the drying is finally completed.

It is not easy to describe the condition of the fruit when it is thoroughly dry. The same characteristics prevail, however, that have been mentioned on page 34 in regard to drying peaches in evaporators, and when the fruit is removed from the trays it also should be handled as previously described. If the fruit is placed in the room or in boxes for curing in the heat of the day, there is less danger of insect infestation than when it is handled at other times.

The weight of dried fruit which a given quantity of fresh fruit will make depends upon the variety, the season, and to some extent upon the methods under which it has been grown as well as upon the manner of handling while drying. The weight reduces from about four or five to one with the dry-fleshed varieties, such as the Muir, to a correspondingly greater shrinkage with the more juicy sorts.

APRICOTS.

In harvesting apricots for drying, a sheet or canvas is sometimes spread under the trees and the fruit that is fully ripe secured by gently shaking the limbs. This reduces somewhat the cost of gath-

ering, but the claim is made that it is offset by the loss that follows from bruising the fruit.

In preparing apricots for drying, the same methods are followed as those already described in connection with the drying of peaches. As the various steps are essentially the same and the same cautions are noted with reference to details, it is unnecessary to consider them in full in the present connection.

In California, the Blenheim apricot is one of the more desirable varieties for drying. While not as large as some other sorts, it ripens uniformly and is productive. The Moorpark and Hemskirk are of good size, but faulty in that the trees are not as productive as desirable and the crops ripen irregularly. The Royal in some sections is reported as too small in size though more or less used for drying. The Peach and Tilton varieties are dried in some sections.

It is said that a weak salt solution lightly sprinkled over the trays before the fruit is spread on them will prevent sticking where there is a tendency in that direction. As a rule, they are sulphured rather more heavily or longer than is advised for peaches. When peaches are treated for two hours, apricots would be left in the fumes perhaps three hours or longer. In some cases operators use three or more pounds of sulphur for a stack of twenty or twenty-five trays, treating for at least two hours, often longer. Some determine when the fruit is sufficiently sulphered by its appearance. If, upon cutting open a piece, it has a watery, somewhat cooked appearance throughout, it is considered ready to be removed from the sulphuring house. Oversulphuring tends to make the fruit stick to the trays.

Apricots, being smaller, dry more quickly than peaches. An exposure to the sun of three to four days usually puts the fruit in suitable condition to stack the trays where they are held for four or five days for finishing. However, the time required, both for exposure and in the stack, varies in different sections as well as with different conditions in the same section. In some localities the exposure is considerably less than the time indicated. Depending on the variety and other conditions as given elsewhere, it requires about $4\frac{1}{2}$ to $5\frac{1}{2}$ pounds of fresh apricots to make a pound of dried fruit.

PEARS.

From a relative standpoint, the drying of pears is of much smaller importance than either apricots or peaches. As in the case of these fruits, pears should be fully mature when dried, though they need to be picked some days in advance of full maturity, as when intended for use in the fresh state.

In preparing the fruit for drying, the individual specimens are halved and the stem and calyx removed. The core is not cut out, as a rule, nor is the fruit peeled. If the pears are very large, they

are sometimes quartered, since drying is facilitated if the pieces are not too large.

The fruit is then spread on trays and sulphured in the manner described for peaches. The length of time that the fruit remains in the sulphuring house and the amount of sulphur used, however, varies very much more widely with different operators than with other fruits. In extreme cases the fruit is continued in the sulphur fumes for 48 hours, at least three charges of sulphur being burned in the compartment during this period. The object of such long-continued sulphuring is to secure fruit that when dry is nearly translucent, such a product being considered as of particularly high grade. However, such extreme sulphuring as this is not recommended by the more conservative operators—a limit of four to five hours being preferred. Even this is two to three hours longer than the more common practice with other fruits. Relatively heavy sulphuring appears necessary, however, in order to secure a product that meets the demands of the trade. Where the extreme limit of sulphuring above mentioned is used, the fruit is usually exposed to the sun for only a short time—one day, or even a half day being the common practice. The trays are then stacked as in the finishing process of peaches, and they are thus allowed to remain until the fruit is fully cured. This commonly requires a period of several weeks.

Where the shorter periods of sulphuring are given, it is necessary to expose the fruit to the sun a somewhat longer time than when the fruit is sulphured for 48 hours. The fruit is sometimes dipped in a rather strong solution of salt before it is sulphured, in the belief that better results are secured.

After the fruit is in condition to remove from the trays it is placed in a pile in some suitable room in the same manner and for the same purpose as peaches. The Bartlett, which is the variety largely used in California, shrinks from about 6 pounds to 1 in drying.

PRUNES.

Prunes that are to be sun dried are prepared in all essential particulars the same as when dried in an evaporator. They should be spread in a single layer on trays which usually are like those used in sun drying other fruits.

Exposed to the sun, the fruit usually dries enough to permit stacking the trays in five to eight days, or longer under some conditions. Some operators expose the fruit to the sun until it is partially dry, then finish in an evaporator at a fairly high temperature—about 160° to 170° F. This method is especially practicable near the close of the season when the fruit does not dry in the sun as rapidly as it does earlier, and it therefore becomes advisable to hasten the process somewhat.

There is some irregularity in the rates of drying of different fruits on the same tray. Before they are stacked, the contents of each tray should be sorted over and the fruits that are distinctly less advanced than the bulk removed. If the fruit was not well graded as to size before being spread on the trays, it may be necessary also to sort out the fruits that are drier than the bulk. This makes it possible to handle the fruit of different degrees of dryness with regard to making the highest grade product possible. Before stacking, the contents of different trays may be combined, as with peaches and other fruits. The trays are usually stacked for about three days or more while the drying is in process of completion. Handled in this manner, the fruit has better texture and more weight than if the drying is completed in full exposure to the sun.

When the fruit is finally in condition to remove from the trays, it is taken up, preferably in the heat of the day, and emptied into boxes or placed in a pile in some clean, well-ventilated room to go through the curing, sweating, or equalizing process elsewhere described. This period may require from six to ten days, or longer if the weather conditions are cold and damp. The fruit during this process should be turned every day or two until it has reached a uniform degree of moisture throughout. It is then ready to be handled for packing.

PREPARING EVAPORATED AND DRIED FRUITS FOR MARKET.

While the packing of dried fruits for the trade is conducted largely as a business which is distinct from evaporating or drying and a large proportion of the product passes out of the hands of the operator before it is packed for shipment, it should help the one who makes the product to know in a general way how it is handled by the packer. Some of the methods in use are here briefly described.

PACKING EVAPORATED APPLES.

GRADING.

In handling evaporated apples, three grades are generally recognized, which are commonly designated as "fancy," "choice," and "prime." Two other grades, which in reality are special grades, are also sometimes recognized, viz, "extra fancy," and a lower grade than prime—usually called prime with some distinguishing prefix—frequently the name of a locality.

The standards demanded for these various grades are about as follows:

"Fancy" is a very white, clean stock, free from all pieces of skin and other objectionable portions which should be removed in trimming, and with a good proportion of the slices in rings.

"Choice" denotes a grade intermediate between "fancy" and "prime," not quite clean enough for "fancy," yet more nearly free from imperfections than the "prime" grade demands.

"Prime" must be a good stock, well cured, and of a generally attractive appearance. It must be comparatively white and mostly free from undesirable portions, but stock having a small percentage of such defects is usually put in this grade.

"Extra fancy," as the name implies, is a fancy grade that is exceptionally fine. It must possess all the qualities mentioned in describing that grade in a marked degree. At least 85 per cent of the slices should be rings.

The grade below "prime" is the stock that has been so carelessly handled and is so unattractive in appearance that it can not maintain the standard of "prime." It is packed for an entirely different and much poorer class of trade than any of the other grades.

FIG. 20.—A "board" of facers.

PACKING.

Evaporated apples are in suitable condition to pack when they have passed through the curing period and the individual pieces have all acquired a uniform degree of moisture.

The package largely used in marketing evaporated apples is a wooden box which holds 50 pounds of fruit when the contents are firmly pressed into it. Pasteboard cartons, holding 1 pound, or half a kilo (1.1 pounds) for certain export trade, are also more or less used.

In packing, the side of the box intended for the top or face is packed first, as in packing fresh fruit in boxes or barrels. The first step in packing, therefore, is to face this side. The facers are slices which are perfect rings. These are usually selected from a quantity of fruit which contains a relatively large proportion of them; they are then placed on thin boards which are slightly smaller than the top of the box, inside measure, overlapping one another in rows lengthwise of the board. Figure 20 shows such a board of facers. The facers are put in place by inserting the board on which they are arranged into the box, which is first lined with paraffin paper, and then with a dexterous movement of the hand flipping the layer of rings against the inner face, or the bottom, which is to become the top of the box.

After facing, the box is filled, the contents being firmly packed in with a press made for the purpose, weighed to insure full measure, and the cover (which then becomes the bottom) nailed on. The cartons usually are filled by hand. Figures 21 and 22 show 50-pound boxes of dried apples as they appear upon being opened.

PACKING PEACHES, APRICOTS, AND PEARS.

Dried peaches, apricots, and pears are usually packed in wooden boxes holding 25 pounds. They are packed, as a rule, without any special attention to grading. The package is faced, in effect, much

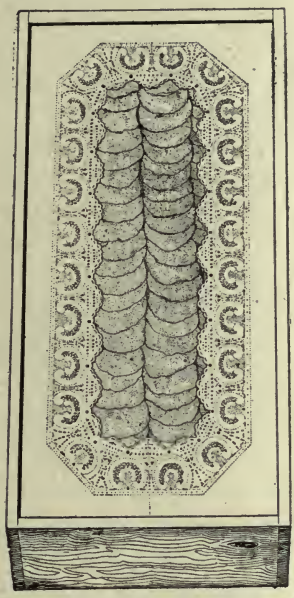

FIG. 21.—A 50-pound box of "fancy" evaporated apples with cover removed.

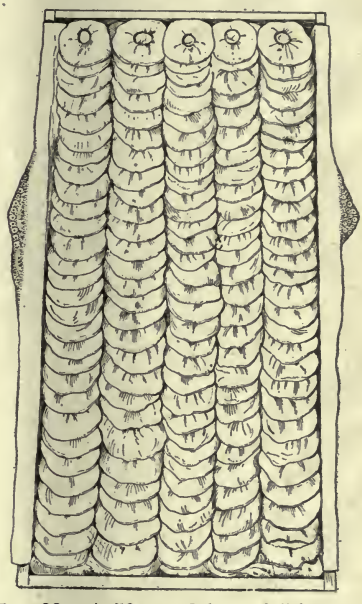

FIG. 22.—A 50-pound box of "fancy" evaporated apples with cover and paper lace removed.

the same as described above in packing evaporated apples, though the pieces are placed by hand rather than by a facing board.

If they have been well dried and contain the proper amount of moisture, the pieces are pliable when they are ready to come from the curing room where the moisture has become uniform throughout during the curing, or sweating, process. In this condition the product may be packed for the trade without further treatment.

However, if the fruit has become so dry that the individual pieces are not pliable, they will not pack well in the boxes. To put the fruit in good condition to pack it may be treated in several different ways with the end in view of making it pliable so that it will compress readily into the boxes.

A common method consists of dipping the fruit in water long enough to moisten the outside. The water used may be cold, tepid, or in some cases it is used boiling hot. Sometimes a little salt is added. The fruit is then spread 2 or 3 inches deep on trays and lightly sulphured, after which it is dried slightly before packing if considered necessary. It is sufficient, commonly, to permit the fruit to remain in a dark room for 24 hours after dipping if it has not absorbed too much water in the dipping. This treatement usually softens the fruit enough to make it pack well. This treatment is said also to prevent the development of any insects or fungous diseases with which the fruit may have become infected while in the curing room.

A good deal of care needs to be exercised in sulphuring the fruit at this time—just before it is packed. It is claimed that most of the complaints which have been made in regard to sulphuring of these fruits are due to excessive treatment just before they are packed rather than to that which they receive before they are dried.

PACKING PRUNES.

Prunes are graded as to size before they are packed, the different grades being designated as 30's to 40's, 50's to 60's, 90's to 100's, etc., the figures indicating the approximate number of fruits in a pound; thus "40's to 50's" means a grade in which 40 to 50 fruits average a pound in weight.

In packing, the boxes are faced as in the case of other dried and evaporated fruits. The fruit is prepared for packing in various ways, all of which have the same objects in view, which are the softening of the individual fruits so they will pack well when compressed, the improvement of the appearance of the fruit, and the guarding against the development of insects.

The fruit is softened by dipping in solutions variously made up according to the preferences of individual packers. Some use a solution made by dissolving common salt in water at the rate of 1 pound to 20 gallons; glycerine, 1 pound to 25 gallons, is also used; still others use different solutions or combinations of solutions.

The salt solution is cleansing and leaves the skin bright and attractive. The glycerine gives a gloss to the skin. The solution is usually kept hot while the dipping is in progress, sometimes being kept at the boiling point.

With reference to the preparation of prunes for packing, Wickson [1] states as follows:

When sufficiently dried the prunes are put through the "sweat," which takes from several days to two or three weeks, and then are ready for grading

[1] Wickson, E. J. The California Fruits and How to Grow Them. Ed. 7, p. 457. San Francisco, 1914.

finishing, and packing. In grading, the prunes are separated by the use of a grader, as already described, into a number of grades, the largest, 40 prunes to the pound, and so on, 50, 60, etc., to the smallest, which may run 100 or more to the pound. Finishing consists in exposing to steam, in dipping in clear hot water, or hot sugar sirup, or in dipping in boiled juice of ripe prunes, peaches, or apples, etc. Although there is a great variety of materials used for "glossing" prunes by different producers, the prevailing practice is to rely upon hot water, to which pure glycerin is added at the rate of 1 pound to 20 gallons. Some growers also add a little brine (having first dissolved the salt and skinned [skimmed] off the impurities). This final hot dip kills insect eggs, and the fruit, after drying off away from the access of insects, should be packed tightly in boxes, usually holding 25 pounds, though 38 to 50 pound boxes are used in foreign trade.

In one method of dipping, the fruit is passed through a revolving cylinder processor placed in a horizontal position and in the bottom of which the dipping solution is carried. The interior of the cylinder is so constructed that as it revolves it carries the prunes around with it. Thus they are in the solution only a portion of the time required to pass the length of the cylinder, and which occupies but a very few minutes. Steam is constantly passed into the cylinder so that when the fruit is not in the solution it is in a hot steam bath. Passing out of this apparatus, the fruit is placed for a short time where the surplus moisture drains away and the fruit is then packed, commonly while still hot.

The dipping and heating of the fruit not only softens it so that it packs well, but it destroys any organisms with which the fruit may have become infected in the curing room.

INSECTS INJURIOUS TO DRIED FRUITS.

A number of insects need to be guarded against with considerable care, not only while the fruit is being dried, but, as previously mentioned, in the curing room, and even after the fruit is packed.

In this connection it will suffice to refer the reader to department bulletin 235.[1]

LAWS RELATING TO EVAPORATED AND DRIED FRUITS.

So far as the writers have been able to learn, only one State has enacted laws specifically regulating the quality or condition of evaporated or dried fruits offered for sale.

In 1904, the New York Legislature amended the agricultural law so as to prohibit the sale of adulterated evaporated apples. This act became a law on April 26, 1904, and is recorded in chapter 391. It is intended primarily to regulate the moisture content of evaporated

[1] Parker, W. B. Control of dried-fruit insects in California. U. S. Dept. Agr. Bul. 235, 15 p., 4 fig., 7 pl. 1915.

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fruit when offered for sale. For the purpose of the act, evaporated apples are considered "standard" if they do not contain more than 27 per cent of water or fluids, as determined by drying for four hours at the temperature of boiling water.

It will thus be seen that evaporated apples, in the terms of this law, are considered "adulterated" if they contain more than 27 per cent of moisture.

The pure food laws of many States also apply in regard to the presence of sulphurous acid, sulphites, or other perservatives in food products. In addition, most of the food laws contain definitions of adulteration which include a statement regarding the presence of a filthy, decomposed, or putrid vegetable substance.

A California statute, approved March 20, 1903, requires that all fruit, green or dried, contained in boxes, barrels, or packages, and offered for shipment in the State be so labeled as to designate the county and immediate locality in which the fruit was grown, but a decision of the supreme court of the State declares this law to be unconstitutional.

The Board of Food and Drug Inspection under the pure-food law enacted at the first session of the Fifty-ninth Congress relative to the amount of sulphurdioxid permissible in evaporated or desiccated fruits ruled under date of March 5, 1908, in food inspection decision 89, amending decision 76, that—

> No objection will be made to foods which contain the ordinary quantities of sulphur dioxid, if the fact that such foods have been so prepared is plainly stated upon the label of each package.
>
> An abnormal quantity of sulphur dioxid placed in food for the purpose of marketing an excessive moisture content will be regarded as fraudulent adulteration, under the Food and Drugs Act of June 30, 1906.

The attention of all interested persons, especially exporters, should further be called to the fact that "the governments of Prussia and Saxony, in order to unify the practices of inspectors of desiccated fruits, have issued decrees fixing the limit of sulphurous acid in desiccated fruits at 0.125 per cent."[1]

The presence of sulphurous acid in desiccated fruits, and also of zinc in fruit dried on galvanized wire racks, has frequently been criticized in foreign markets and has been the source of unfavorable judgment, resulting in more or less agitation favoring laws restricting or prohibiting the sale of such fruit.

[1] Notice to exporters of desiccated fruits. (F. I. D. 7.) *In* U. S. Dept. Agr. Bur. Chem. Food-Inspection Decisions 1 to 25, p. 17. 1905.

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FIRE PREVENTION AND FIRE FIGHTING ON THE FARM

H. R. TOLLEY
Scientific Assistant

A. P. YERKES
Assistant Agriculturist

FARMERS' BULLETIN 904

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF THE SECRETARY

Contribution from the Office of Farm Management

W. J. SPILLMAN, Chief

Washington, D. C. January, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

MILLIONS of dollars' worth of agricultural wealth is destroyed by fire in the United States each year. At normal prices and with an average crop, it would take the greater part of the potato crop of the country to offset all that is lost annually through fires on farms.

This is a dead loss to the Nation—for the fact that most individual losers are partially reimbursed through insurance does not in the least reduce the drain on our national resources—and it is a loss that is largely preventable.

This bulletin suggests to farmers some easy ways in which this great waste of our national wealth may be reduced.

FIRE PREVENTION AND FIRE FIGHTING ON THE FARM.

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MOST FIRES PREVENTABLE.

ORGANIZED fire prevention long ago became a science in our cities, but there is still a tendency for many farmers to consider a destructive fire as an act of Providence and loss from fire as unavoidable. Yet a comparatively small amount of time intelli-

FIG. 1.—A fire on the farm usually makes a clean sweep.

gently applied by the individual farmers in the study of conditions which are likely to cause fire, and of money spent in placing simple and inexpensive fire-fighting equipment would eliminate a large percentage of this waste.

NOTE.—Credit is given to Mr. V. N. Valgren, investigator in agricultural insurance of the Bureau of Markets, for suggestions concerning this bulletin.

Practically every fire, except those of incendiary origin, is preventable—some carelessness or neglect is usually responsible.

The object of this bulletin is to interest the reader in fire prevention on his own premises, to induce him to investigate conditions which exist there and bring him to realize that he would be personally responsible for any fire that might occur, and to urge that he take immediate action to eliminate all unnecessary fire hazards from his premises, at the same time providing such fire-fighting facilities as conditions warrant. Suggestions are offered which will enable the farmer to study his fire problem intelligently and combine economy and efficiency in the protection of his property.

The farmer should study his buildings and their contents from the point of view of the fire inspector of the city, whose sole business is to see all the things that can be done to improve conditions so that fire can not easily start, and to determine the best ways of fighting any fires that may start. He should remember that any preventive or protective measures which he may take are for his own benefit, and that protection sufficient to prevent a fire is cheap as compared with the loss entailed by the average farm fire. Every building or set of buildings has certain points which are more susceptible to fires than others, but adequate protection must be provided for the entire premises before the owner can be sure that some weakness due to oversight or neglect will not neutralize the good effect of all the work previously done.

Most farmers carry fire insurance on their buildings and contents sufficient partly to repay them for any losses that may occur; but this insurance is paid from premiums which are nothing more than a tax collected from the policyholders for this purpose. The loss occasioned by a serious fire is such that very few people can afford to be without fire insurance, but attention to the prevention of fire would result in reducing the number of fires, and, therefore, the rate of premiums necessary to cover the fire losses. This would be felt quickly in mutual companies which are owned and managed by the policyholders themselves and in which the premiums are fixed by the actual losses.

FIRE PREVENTION.

The common causes of fire are known to everyone, and there is no one who does not know how to put out a fire if the means are at hand. But there is a tendency for the average property owner to become exceedingly careless in his efforts toward fire prevention and extinction.

Some of the more common fire hazards found on nearly every farm are enumerated below. The idea is not to tell the reader something new, but to make him realize that he frequently tolerates conditions

which are likely to cause a destructive fire, and that he must exercise some reasonable precaution if he expects to do his share in reducing the fire bill of our Nation.

CARELESSNESS WITH MATCHES.

All matches are dangerous from a fire standpoint. The ordinary "parlor" matches take fire at a very low temperature and can be lighted in many ways. They sometimes fall to the floor unnoticed and are lighted by being stepped upon. When one is being scratched part of the flaming head may fly off into some inflammable material. Children are fond of playing with matches and do not realize the danger connected with them; even babies soon learn by imitation to strike them. Match holders should always be placed well out of reach of the younger members of the family. Many fires are started by matches carelessly thrown down while they are still in flame or before the stick has ceased to glow. At all places in the house where matches are usually struck a fireproof receptacle should be provided for the burned matches, and this should be emptied frequently. Smoking or striking matches in the barns or stables should never be allowed. Nor should hired hands or others be permitted to carry matches loose in their pockets. If the carrying of matches is necessary, insist upon the use of a good metal match safe; this will prevent single matches being pulled from the pocket accidentally.

The double-dipped matches which have come upon the market in recent years (those with heads of two colors) are much safer than the older kind, for they will not light except when scratched on the small tip, they are very unlikely to light when stepped upon, and the heads do not fly readily. But the least dangerous matches are those which will not light unless they are scratched upon the box which contains them. The manufacture and sale of single-dipped matches is recognized as undesirable by some States, which have laws forbidding it.

KEROSENE.

Kerosene is used on almost every farm in the country and has been responsible for many destructive fires. It requires quick and intelligent action to prevent an overturned lamp or lantern from setting fire to surrounding objects. Lamps with glass bodies, when overturned, frequently break and spill the oil. If lighted at the time, serious results might follow. Lamps with metal bodies are not subject to this hazard. Lamps and lanterns may explode if they are not handled carefully or if the oil gets too low in them. Some lanterns, as, for instance, switchmen's, are expressly designed to avoid danger when not handled carefully. The wick should always fit tightly. Enough vapor to produce an explosion may be generated

if a lamp or lantern is refilled while still hot. For the same reason refilling should always be done at a safe distance from a hot stove. Lamps should never be set on the floor or upon the edge of a table, box, or rickety stand. Electric lanterns, operating with one or two ordinary dry cells, such as are used on gasoline engines and automobiles, could very well take the place of many of the old kerosene lanterns in the country. These will not start fires even if handled in the most careless manner and are also much cleaner and more convenient, always ready for use, and not affected by wind or rain.

Small individual electric-lighting plants, designed particularly for farm use, can now be bought for from about $150 up. There is absolutely no danger of fire from these outfits if the equipment and wiring are properly installed, and they not only eliminate the use and danger of kerosene lanterns and lamps but furnish a much better light, at the same time being cleaner, more convenient, and sanitary. A properly installed gas plant is also safer and superior to the kerosene lights, though not equal to an electric plant. In figuring the cost of installing modern lighting facilities in the home, due consideration should be given to the greater protection from fire which is entailed by such installation.

GASOLINE—IN COMMON USE AND VERY DANGEROUS.

With the advent of the automobile, the farm tractor, and the stationary gasoline engine, gasoline has become almost as common as kerosene on the farm. This is the most dangerous petroleum product in common use. Even at ordinary temperatures it gives off a very explosive vapor, and it burns more fiercely than kerosene. The only really safe place to keep the gasoline supply is in a tank buried underground, and it should never under any circumstances be kept inside any building where it may be necessary to take a kerosene or other open light or where a gasoline engine of any kind will be operated. If the container permits vapor to escape, a spark from the electrical equipment or a flame from the exhaust pipe of any gasoline engine may easily ignite it. *The vapor from a single pint will render the air in an ordinary sized room explosive.* It is heavier than air, and there may be a great deal of it near the ground or floor in the vicinity of a tank, while the odor would not be particularly noticeable to a person standing. For this reason it is especially hazardous to set a lantern on the ground or floor near a gasoline container of any kind, even out of doors, as the flame may follow the vapor from the lantern to the container. Open-flame lights should never be allowed in the garage or the building containing the farm tractor or gasoline engine, and such a building should never be heated by a stove. It is safer if the automobile and tractor are run outside before the tanks are filled, so that the vapor may

be carried away immediately, and the tank of a stationary gasoline engine should be filled only in daylight and while the engine is not in operation. Water, unless applied in very large quantities, has no effect on burning gasoline except to spread the fire, and this fact makes such fires all the more dangerous.

BURNING BRUSH OR RUBBISH—BONFIRES.

In order to get rid of undesirable brush or rubbish on the farm it is often desirable to burn it, and at times an outdoor fire is almost a necessity. Such a fire should be watched from the time it is kindled until the last ember is dead, since fires of this type are responsible for the destruction of many buildings, fences, forests, fields of grain, etc. A fire should never be built so big that it could not be scattered and extinguished in a few minutes if the wind should happen to become dangerously high, and it should never be left until after the embers have been scattered and there is no possibility of it again flaming up. If water is convenient the ashes should be well soaked as a final precaution. Many destructive fires have been caused by such fires which were thought to be burned out and dead, but which contained hot coals which the wind blew into flame and carried to near-by inflammable material. Children like to play around a fire, to throw things into it, or pull burning sticks from the flames. This should never be tolerated, as it is likely not only to spread the fire and cause the destruction of valuable property, but to set fire to the children's clothing and endanger human life as well. Where possible, rubbish should be burned in a brick furnace or in a metal container designed for the purpose. Metal containers having large openings around the side may be dangerous in that fire may easily get through the openings.

In some sections of the country the practice of burning off stubble fields and cornstalks before plowing is common, and the fire sometimes spreads to the fence line or to stacks of hay or straw or even into the farm buildings. This danger can be eliminated to a great extent by plowing a few furrows around the field before the fire is started.

Bonfires, Christmas trees lighted with candles, and Fourth of July celebrations where gunpowder is used belong in the same category with rubbish fires. Any fire kindled in an unaccustomed place is likely to be dangerous. Lighted candles may be dangerous, particularly in such places as barns, closets, and attics.

DEFECTIVE FLUES AND OVERHEATED STOVES.

Stoves, stovepipes, and chimneys, if improperly installed or carelessly used, always constitute a fire menace. Stoves should not be placed too close to papered walls or woodwork unless proper pro-

tection is provided for them. The floor near stoves or fireplaces, where exposed to heat or the dropping of hot coals, should also be covered with some noninflammable material.

Stoves and stovepipes should be put up solidly. In general, stovepipes should not pass through wooden partitions or through ceilings, and in case such installation can not be avoided tile insulators or other fireproof material should be placed around the pipe. Chimneys should be examined periodically for cracks. If cracks occur in a chimney they should be filled with plaster or cement at once, as fire often creeps through such cracks to the woodwork. Cracks that may be dangerous and that might not otherwise be found can be discovered by building a smudge in the stove and placing a board or wet sack over the chimney. Smoke will then be forced out of the cracks.

All chimneys should be cleaned regularly to remove the soot and any other inflammable material that may have got into them. This is best accomplished by means of pieces of metal (such as scrap tin), limbs of an evergreen tree, or a bundle of brush attached to a rope, chain, or wire, and worked up and down in the chimney from the top.

The door leading to the firebox of a stove should not be left open to check the draft, for live coals are likely to fall out on the floor, and the clothing of a person near the stove may be drawn into the fire. Suitable dampers should be provided in the pipe if the stove is not equipped with them. For the same reason open fireplaces should not be used unless provided with an effective screen to keep sparks and hot coals from flying out into the room. Stoves should always be of ample size for the space they are expected to heat, as if they are too small they are liable to be overheated (and the pipe at the same time) or filled so full of fuel that fire falls out on the floor when the door is opened.

FLYING SPARKS AND CINDERS.

Cinders from chimneys, locomotives, or steam traction engines often ignite dry wooden shingle roofs and start many fires in straw, stubble, and grass during dry seasons. Most States have laws requiring locomotives to carry spark arresters on their smokestacks, and all steam engines on the farm should be required to have them. When such engines are used in the stubble field or near dry grass or straw they should be watched to see that cinders from the stack or hot coals from the fire box do not start a serious fire. They should always be placed as far as possible from buildings, and preferably on the lee side.

From a fire protection standpoint it is unfortunate that nearly all farm buildings are covered by shingle roofs. A dry shingle roof is one of the most inflammable things imaginable, but on account of

their durability, light weight, and low cost shingles probably will continue to be used indefinitely as roofing for farm buildings. However, when a new building is being constructed or a new roof is being put on an old one it is at least worth while to consider the use of fireproof roofing. With the growing scarcity and high price of lumber fireproof substitutes for shingles are becoming more numerous and easily available.

When shingles are exposed to the weather for a short time they take on a rough, fuzzy appearance, due to the fibers on the surface becoming loosened. The sun from without and the heat from within the building combine to extract every trace of moisture from them. If a cinder or spark happens to strike the roof the roughened surface tends to hold it there, and it is likely to set the roof on fire before it goes out. One way of lessening this danger is to paint the roof. The paint smooths down the rough surface of the wood, making it much easier for cinders to roll off to the ground when they strike the roof; it prevents the shingles from warping and forming pockets for the cinders to lodge in, and if cinders do stick on the painted surface considerably more heat is required to ignite it than to fire the rough surface of the unpainted shingles. Dried paint is mostly metallic or mineral pigment from which the oil is all evaporated, and in itself is not inflammable. Painted roofs have the advantage of being more attractive than unpainted ones, though it is a mooted question as to whether oil paint lengthens the life of a shingle roof. Where buildings are frequently exposed to danger from flying sparks or cinders, some means should be employed to make the roofs reasonably safe from them.

SPONTANEOUS COMBUSTION.

Many destructive fires have been caused by the spontaneous ignition of hay, especially clover and alfalfa, both in mows and in stacks. The first cutting of alfalfa seems to be the most dangerous in this respect. If hay of this kind has rain or dew on it or if the stalks are not cured thoroughly when it is put up, the moisture will cause fermentation, which may produce sufficient heat to start a fire. The combustion always starts in a part of the mow or stack at some distance from the surface, but it can not continue long without oxygen from the outside, and it may cease without ever having come to the surface. Its presence can be detected by a peculiar sooty odor or by smoke irritating to the eyes. It may take place from a few days to several weeks after the hay is put up. There is little danger from this source if the hay is properly cured. Spontaneous combustion has been known to take place in damp fodder and straw, and bins of moist grain and seeds are also dangerous in this respect. Manure piles create a great deal of heat, but manure does not burn readily.

Cloths, waste, and sawdust saturated with organic oil of any kind are even more subject to spontaneous ignition than hay. Such oils unite with oxygen when exposed to the air, and heat is produced. If the oil is spread upon cloth or other material which ignites easily, and if the conditions are such that the heat is not radiated, the temperature may become so high that a flame will be produced. The accumulation of such materials should be guarded against.

POORLY CONSTRUCTED SMOKEHOUSES OFTEN TAKE FIRE.

Smokehouses for curing the family supply of meat are especially dangerous if poorly constructed of wood. It is possible to construct a smokehouse out of stone, brick, or, preferably, concrete, at only a slight increase in cost over wood, that will be practically fireproof. Needless to say the smokehouse should be placed at some distance from the other buildings, and should be watched carefully while the meat is being smoked.

SPECIAL EQUIPMENT REQUIRING THE USE OF FIRE.

Incubators, brooders, feed-cookers, evaporators, and other equipment requiring the use of fire are found on many farms. Such equipment always constitutes a special risk. There is a great difference in the innate hazard of different types of these apparatus, and the first step in reducing the risk from them is to purchase only the best types and to make the place and manner of installation such as to involve the least danger. But wherever placed, constant care in operation is necessary to insure even comparative safety.

LIGHTNING RODS REDUCE THE DANGER FROM LIGHTNING.

The average annual property loss from lightning in the United States is about $8,000,000, and by far the greatest part of this loss is in the rural districts. Lightning is an especially great hazard in those parts of the country where thunderstorms are frequent, and practically the only protection against it is the lightning rod. Many people hold the opinion that lightning rods do not protect a building at all, and that they actually increase the danger if they are not properly installed. But it is now definitely known that they afford *some* protection in almost every case, and if they are installed properly and intelligently they reduce the risk of loss from lightning to an almost negligible quantity. From such statistics as are available regarding damage from lightning in parts of the United States and Canada where thunderstorms are frequent, it has been found that properly installed rods reduce the probability of a barn being destroyed by lightning by something like 99 per cent, and of a house by as much as 80 or 90 per cent.

Directions for installing lightning rods are given in Farmers' Bulletin 842, Modern Methods of Protection Against Lightning, which may be obtained free from the Division of Publications, United States Department of Agriculture.

Farmers' mutual fire insurance companies in some instances take cognizance of the protection afforded by lightning rods and make substantial reductions on the premiums charged on rodded buildings, while others only insure buildings which are rodded in a manner satisfactory to them. Such reductions will soon pay for the cost of installation of the proper rods. In view of the fact that lightning is one of the greatest causes of fires in the rural districts, all companies which insure farm property against fire should make a considerable reduction of premiums in favor of buildings which are protected by a satisfactory system of lightning rods, and the owners of such buildings should be careful to select a company which grants such reductions.

FIRE PREVENTION IN THE ERECTION OF NEW BUILDINGS.

The fire hazard should be considered in the location and construction of all new buildings on the farm. Many groups of farm buildings are so located and constructed that any fire which might break out in one building would be almost sure to destroy the whole group. When a new building is to be erected it is worth while at least to consider placing it where it will be reasonably safe from fire starting in any other building and where it will not be a menace to other buildings. Concrete construction is being used on many farms, and it is especially desirable for smokehouses, incubator rooms, and any other small buildings which are exceptionally subject to loss by fire. The first cost of a well-constructed concrete building generally will be greater than that of a wood building of the same size, but the concrete will last practically forever, and will seldom need paint or repairs. A fire in such a building can do but slight damage to the building itself, and there is very little likelihood of its spreading to any of the adjoining buildings.

FIRE FIGHTING.

While the easiest way to fight fire is to prevent it, and observance of the points mentioned in the preceding pages will prevent it to a great extent, some provision should be made for promptly extinguishing any fire which may start in spite of precautions. Nearly all farm products and equipment are combustible and are contained in frame buildings. It is almost a necessity that fire be maintained in some of these buildings during a part of the year, and carried into most of the remaining ones occasionally. In a large percentage of

cases someone is in the building when a fire starts. Thus all buildings should be equipped with some kind of fire-extinguishing apparatus, for all fires are of the same size at the start, and most of them are discovered in time to be put out by a single person if the means are at hand. The apparatus should be located in convenient places known to everyone who frequents the building, and should always be kept ready for instant use, and a ladder long enough to reach the roof should be kept in a handy place if there is no other way to get to the roof quickly. Fire insurance companies give special rates to all property owners in cities who equip their premises with satisfactory fire-extinguishing apparatus, and many companies would doubtless be willing to make similar arrangements in the case of farm buildings so equipped.

WATER.

A pail of water is the oldest, simplest, and also the cheapest fire extinguisher. Fire buckets are found in all places of business and manufacturing plants, and there is no reason why pails of water to be used for no other purpose should not be found in every farm building. They are so effective in extinguishing small fires that insurance companies grant lower rates to many merchants and manufacturers who follow this practice, yet there are very few farm buildings where buckets of water are kept in fixed places to be used for fire only, although it would cost but little and require only a slight amount of work to maintain such protection. Most people rely on pumps to furnish water when a fire breaks out; but the well may be at a considerable distance from the fire, and the delay caused by having to hunt buckets, pump the water, and carry it to the fire may be sufficient to permit the flames to spread beyond control. The usefulness of the fire bucket depends upon its being instantly available. To insure this the water should never under any circumstances be used for other purposes, the buckets should be inspected and refilled at regular intervals, measures should be taken to prevent the water from freezing in cold weather, and the buckets should always be kept at certain fixed places. They should be set on shelves or hung on brackets, and not put on the floor where they may be upset or have other things piled on them. If they are provided with covers the water will not evaporate so quickly as from open buckets, nor will it get full of dust and dirt and develop an offensive smell. The water can be kept from freezing in all except very low temperatures by adding two pounds of common salt to each bucketful. In some cases calcium chloride may be preferable to common salt, as it will not cause deterioration of a metal bucket. If the buckets are specially painted or labeled they will be more conspicuous and there will be less likelihood of their being used by careless persons for other purposes than fire fighting.

In buildings which are at a considerable distance from a source of water it is advisable to install a cask or tub filled with water to reinforce the buckets. On many farms there are plenty of vessels suitable for the use mentioned which could be placed around the premises without expense and in only a few minutes' time.

A little practice in throwing water may be a very useful thing. A single bucketful if applied correctly may do more toward extinguishing a fire than a barrelful thrown awkwardly. The knack of throwing a broad sheet of water in a semicircular sweep is easily learned and is useful on a spreading fire on the floor. Water dipped out with the hands or a broom and sprinkled on the fire is often more effective than that thrown at the fire from a distance. The water should be applied to the base of the fire and not up in the flames and smoke.

The principal objections to water buckets are that they are unsightly if placed inside the house, are likely to be used for something other than fire, hold comparatively little water at the best, require a certain amount of attention if they are always to be full and ready for instant action, and are of little use on fires in oils and volatile liquids, such as gasoline or kerosene. However, they are the best form of fire protection the farmer can get for the money.

Water-supply systems which furnish water under pressure afford excellent fire-fighting facilities if the necessary hose and connections are provided and kept ready for use in emergency. This fact should be taken into account when considering the cost and advisability of installing such a system. Existing plants of this kind can be altered at small cost so as to provide additional fire-fighting facilities.

CHEMICAL EXTINGUISHERS HAVE MANY ADVANTAGES.

The chemical extinguisher has come into general use in recent years, and it has many advantages over water buckets. Since it can be used for nothing else, it is always sure to be in its place and ready when needed. Furthermore, some types of chemical extinguishers are effective in subduing fires among oils, where water is of no value.

The chemical extinguisher in most general use is the soda-acid variety with a capacity of about 2½ gallons of water. More than 20 firms manufacture approved apparatus of this type. These apparatus generally cost from $7 to $12. Their construction is simple and they are easy to operate. An extinguisher of this kind consists of a closed metal tank strong enough to withstand considerable pressure and partly filled with a solution of bicarbonate of soda (baking soda). In the top of the tank is a bottle of sulphuric acid, which is closed by a loose-fitting lead stopper. The only outlet to the tank is a rubber hose equipped with a nozzle. To operate the extinguisher the tank is simply turned bottom upward. This

permits the sulphuric acid to escape gradually around the stopper, which drops out against the top of the tank. The acid comes in contact with the soda solution; carbonic-acid gas, which produces great pressure, is generated, and the water and gas are forced out through the hose and nozzle. Both the water and the gas, which is noncombustible, assist in extinguishing the fire. The apparatus in most general use is about 2 feet in height and is intended to be hung on the wall. The chemical extinguishers which are approved by insurance companies are tested to withstand a pressure of 350 pounds. They are designed to hold 2½ gallons of water mixed with 1½ pounds of bicarbonate of soda, and the bottle holds 4 ounces of acid. The stream which is thrown at the blaze has a range of from 25 to 40 feet and will flow for about one minute. If applied correctly the contents of a 2½-gallon extinguisher are equivalent to many times that volume of water thrown from pails. These extinguishers can be refilled and used many times. When not in use they require no attention, except that they should be discharged and thoroughly cleaned and refilled once a year, and must be protected from freezing. Specific directions for operating and refilling are printed upon a plate attached to the tank of all approved makes. The chemicals for refilling can be purchased at any drug store for half a dollar or less, and a supply should always be kept on hand. These extinguishers are useful on any fire which water will quench, but are not very effective in gasoline or kerosene fires.

Another type of chemical extinguisher consists of a quart of fluid in a double-action metal syringe, the handle of which is worked back and forth to eject the liquid. The chemical agent which smothers the fire is carbon tetrachloride. This is a liquid which does not freeze until a temperature of 50° F. below zero is reached. When the temperature rises to about 200° F., very nearly the temperature required to boil water, it turns into a heavy vapor, which covers and smothers the fire. It is especially useful in extinguishing fires on which water or carbonic-acid-gas extinguishers have little effect. Burning oil, gasoline, kerosene, or acetylene generally can be subdued with it and it is especially valuable in the garage. It is not poisonous and evaporates quickly without damaging articles on which it is thrown. However, a large quantity of the vapor may cause suffocation of persons remaining in a closed room with it. Caution in its use is therefore necessary. One-quart extinguishers of this type can be purchased for about $8 and liquid for refilling them costs about $1.50. These extinguishers are approved by all fire insurance companies.

The Department of Agriculture in the course of an investigation of dust explosions in grain separators developed an automatic fire extinguisher intended to afford protection irrespective of the cause

of the fire or explosion. It is described in Department Bulletin 379, on page 22 of which is the suggestion that when not in use on the separator this device can be mounted on running gears and used for general fire protection about the farm.

DRY-POWDER EXTINGUISHERS.

There are on the market many makes of extinguishers consisting of sheet-metal tubes filled with powder, which decomposes when thrown on a hot fire and produces a noncombustible gas which smothers the flames by shutting off the oxygen. The manufacturers recommend them for fires in confined spaces, and especially for chimney fires, and in many cases they have been effective in curbing gasoline and oil fires. The ingredients are coarsely powdered, decompose easily without explosion, and give off a strong odor and much smoke. They appeal to many on account of their low cost when compared with other extinguishers, but their value has been greatly exaggerated and most experts in fire protection do not recommend them. Their use in attempts to extinguish fires on which they can be of little help is likely to cause disastrous delay in the use of water or other approved agents.

"HAND GRENADE" EXTINGUISHERS.

Glass bottles of spherical form containing fire-extinguishing liquids of various kinds are sold in many places. The bottle is to be thrown on the fire and broken and the liquid thus liberated. When heated the liquid gives off a noncombustible gas, and in some cases is supposed to encrust the burning material with a fireproof chemical and thus smother the fire. These grenades are not as dependable as other forms of extinguishers. Their capacity is small, it is difficult to throw one of them to the base of the fire, and sometimes they do not break when thrown. As in the case of the tubes of dry powder, they are likely to cause serious delay in the use of better extinguishing agents.

SAND FOR EXTINGUISHING OIL FIRES.

Sand is a very good extinguisher of burning oil in case of a small fire on a floor or in a shallow container. Water is of little value in fires of this kind unless a large quantity of it is at hand, for if applied in small quantity it will generally serve only to scatter the burning material and make the fire more difficult to control. Sand is not very efficient if the fire is in a tank or bucket, since the sand sinks to the bottom of the vessel and allows the fire to keep on burning. Pails of sand are recommended in many ordinances applying to garages, and, when all things are considered, are probably superior to anything except good chemical extinguishers. Sand is

very heavy, and the bucket containing it should be small or else only partly filled, so that it will not be too heavy to carry. A light, long-handled scoop or dipper might be useful for applying the sand to the fire.

SAWDUST FOR EXTINGUISHING OIL FIRES.

Sawdust is recognized as a fairly efficient extinguisher of oil fires, especially if the oil is in a deep container. Sawdust poured on burning oil floats and smothers the fire by shutting off the oxygen. Sawdust itself is somewhat inflammable, and if it is to be used care must be taken that it does not become oil-soaked and as hazardous as the oil itself. If two or three pounds of common soda are mixed with a bucketful of sawdust, it is almost entirely incombustible; and if the fire on which it is thrown is very hot the soda will give off a gas which aids in smothering the flames.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO THE SUBJECT OF THIS BULLETIN.

Modern Methods of Protection Against Lightning. (Farmers' Bulletin No. 842.)

Dust Explosions and Fires in Grain Separators in the Pacific Northwest. (Department Bulletin No. 379.)

Organization and Management of a Farmers' Mutual Fire Insurance Company. (Department Bulletin No. 530.)

Farmers' Mutual Fire Insurance. (Yearbook Separate No. 697.)

Lightning and the Electricity of the Air. (Weather Bureau Bulletin No. 26.)

Recent Practice in the Erection of Lightning Conductors. (Weather Bureau Bulletin No. 37.)

SOME OTHER PUBLICATIONS RELATING TO FIRE PREVENTION AND PROTECTION.

Day, W. H. Lightning Rods. Ontario Department of Agriculture, Bulletin 220. 38 pp. Toronto. 1914.

Gardner, Henry A. Fire Retardant Paints for Shingles and Other Wooden Structures. Institute of Industrial Research Bulletin No. 42. Washington. 1914.

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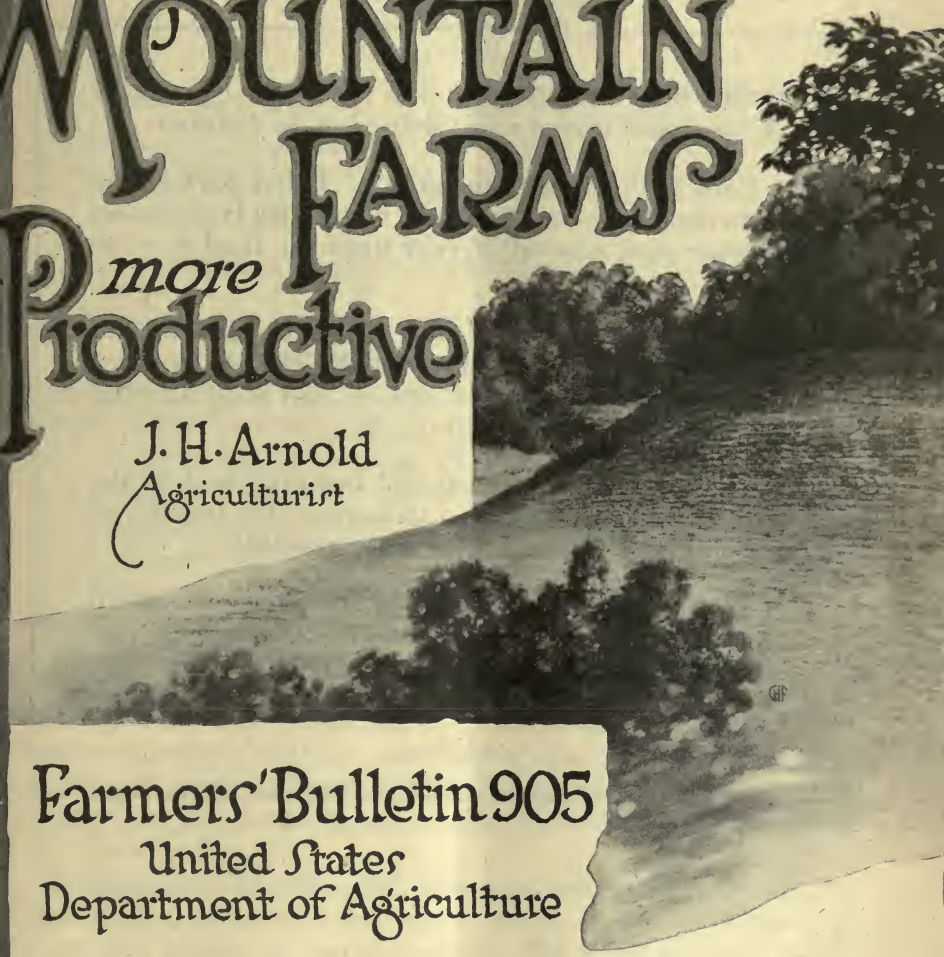
Ways of Making Southern MOUNTAIN FARMS more Productive

J. H. Arnold
Agriculturist



Farmers' Bulletin 905
United States
Department of Agriculture

Office of the Secretary
Contribution from the
Office of Farm Management
W. J. Spillman Chief

Washington D.C.
August 1918

THE SOUTHERN mountain farm often produces no more than a scant living for the family.

Corn is the chief crop grown. Often part of the farm lies idle, being "rested," while corn is grown on another part year after year until the land is worn out.

By growing three or more crops in rotation, including clover, the farmer will be able to produce larger crops, make more money, and keep all crop land under cultivation all the time.

Cattle, hogs, and sheep will not only add to the cash income, but will help to increase the fertility of the soil, and render larger crops possible.

This bulletin describes crop rotations for small mountain farms in the southern Alleghenies, and gives complete directions for starting a crop rotation that will make poor mountain land more productive.

WAYS OF MAKING SOUTHERN MOUNTAIN FARMS MORE PRODUCTIVE.

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FARMING CONDITIONS IN THE MOUNTAINS.

NEARLY THE WHOLE of West Virginia, a large part of Kentucky and of Tennessee, and the western portions of Virginia and North Carolina form a more or less distinct agricultural region, rugged and mountainous, but thicky settled with people who make their living mainly by farming. Three million five hundred thousand people would be a fair estimate of the farming population living on approximately 500,000 farms. Not counting towns, there are nearly twice as many people per square mile in this mountain region as in Iowa, and about the same number per square mile as in the rich blue-grass region of Kentucky.

As a rule the small mountain farm does not produce more than a scant living for the farm family. Even when there are additional earnings from outside sources the total income is usually small. Besides necessary clothing considerable quantities of meat, flour, and canned goods, shipped in from the outside, are bought. Frequently hay and grain are hauled long distances over bad roads to feed work stock.

In some parts of this rough mountain region large or medium-sized grazing farms have developed. These are usually situated on lands well adapted to pasture grasses. The small mountain farms considered in this bulletin, however, have only small areas in cultivation or pasture, and are usually out of reach of markets for staple farm crops. Often to reach these farms it is necessary to travel from 10 to 35 miles from a railroad, sometimes over rough, hilly roads, which during the winter and early spring are frequently impassable

for wagons or other vehicles. Many farms can be reached only by traveling on foot or horseback over mountain trails. Under these conditions the mountain farmer, as a rule, aims to produce no more than can be consumed profitably at home. Occasionally also such home industries as spinning, weaving, or the making of furniture and baskets are maintained, so that a fairly comfortable living may be had without much trading and use of money.

Some mountain farms, however, are more favorably situated. Farms along the larger streams, which follow winding courses

FIG. 1.—View of Oneida Institute, Clay County, Ky. This is a private school for the education of mountain youth, founded by John Burns, who was reared on a farm near by. A farm is connected with the institution to raise food for teachers and students and to provide work for students who must pay their way by labor. The stream in the foreground is a branch of the Kentucky River.

through narrow strips of bottom land between hills or mountains, have some level land. These are fortunately situated, for they usually have access to the main roads, and the level alluvial bottoms are frequently enriched by the overflow of streams. Others are situated on high and more or less level plateaus, where usually it is comparatively easy to cultivate land and to reach markets. In the foothills of the mountains, and scattered here and there in the more fertile lowlands, are farms with more or less level but thin and stony land, often poor in quality. These are also classed as mountain farms, since they are managed in about the same way as are the farms on the steeper lands.

In the densely populated sections, where the majority of farms are largely rough forest land, the area that can be used for growing crops is limited, and under present management and practice hardly enough land is available to produce the food necessary for home consumption. Hence, the small area under cultivation is devoted largely to crops which have high food values, such as corn and beans. There is little pasture for live stock. In places not quite so thickly populated, where the land is not so rough, and where some parts of the farm may be devoted to wheat, rye, clover, and grasses, the improved areas are larger, a smaller proportion of the cultivated land is devoted to corn and beans, and more live stock is raised.

These mountain farms usually range in size from 40 to 200 acres. Generally about one-fourth to one-third of the farm area is cultivated and the remainder is left in woods. Sometimes these woods furnish a small amount of pasture and occasionally there is some open pasture in addition to the cultivated land.

SOME TYPICAL FARMS.

On the small mountain farms in the more thickly populated districts of eastern Kentucky, a fairly representative section of the mountain region, the land is usually distributed about as follows:

	Acres.
Woods	48
Idle land "resting" or partly in pasture	20
Corn	12
Hay or other forage	2
Oats	1
House and barn	½
Garden	½
Sorghum	¼
Potatoes	¼
Beans	¼
Orchard	¼

Corn is the main crop here. It produces more food per acre than any other crop. Beans, Irish potatoes, and sweet potatoes are important. About one-half acre is commonly devoted to a garden which supplies vegetables during the growing season. Honey, sorghum, and molasses take the place of sugar. Most mountain farms produce, in addition to other crops, more or less fruit. Some wild fruits are still available.

Hogs, which are depended upon mostly for meat, get a large amount of their food from nuts and acorns, locally known as "mast." Frequently, however, mast fails, and there is an increased demand on the corn crop for feeding. Most farms possess at least a cow or two, and frequently a few sheep are kept to produce wool and meat.

A large number of the cattle purchased by the lowland farmers are raised on these mountain farms. They are usually sold when yearlings or 2-year-olds. In Tennessee and in parts of other States it has long been the practice of farmers in the lowlands to buy in the fall mountain ewes to breed and raise lambs for the early summer market. This has been profitable, especially on farms raising considerable winter wheat, which can be grazed by sheep. Many such ewes are sold by these mountain farmers.

According to the latest United States census, it is calculated that the average receipts on about 100,000 mountain farms were as follows:

Live stock	$80
Poultry and eggs	2
Dairy products, mainly butter	18
Total	100

Of course, practically nothing is sold from many of these farms, especially the smaller ones, while the larger and more prosperous have an income of several hundred dollars from live stock and live-stock products.

Where there is a larger proportion of tillable land than is found on the typical mountain farms, it is possible to devote a proportionally larger area to small grain, clover, and grasses, somewhat as follows:

	Acres.
Woods	46
Idle land ("resting," sometimes partly in pasture)	25
Corn	15
Hay and other forage	3
Oats	2
Wheat	2
Rye	1
Sorghum	1
House and barn	½
Garden	½
Orchard	¼
Potatoes	¼

This type of mountain farm is found in the more level portions of the mountain region, in the foothills, and on the thinner and poorer soils in the lowlands. While on the average farm of this type the area devoted to crops is larger than on the type of farm just described, the amount of corn raised is about the same. There are practically no beans, these being replaced by wheat and rye. More hay and other forage is raised and more land can be utilized for pasture. There are more cattle and sheep, but usually fewer hogs. Generally speaking, these farmers have larger incomes, devote less time to home industries, and buy more off the farm than

those on the farms with smaller crop areas. The farms are, as a rule, more accessible to railway market points.

Small farms of still another type are found on the high mountain plateaus, where conditions usually are more favorable for meadow and pasture grasses. The following is the typical distribution of acreage of this type of farm, containing usually 80 to 100 acres, on the high plateaus of northern West Virginia.

	Acres
Woods	24
Woods pasture	12
Permanent pasture	15
Rotation pasture, or idle land "resting"	6
Corn	6
Hay or other forage	14
Oats	4
Wheat	2
Buckwheat	2
House and barn	½
Garden	½
Potatoes	¼
Orchard	¼

The most striking feature in the cropping system on these farms is the small amount of corn raised. The land devoted to hay and other forage is about equal in amount to land in field crops. A much larger portion of the land is used for pasture than is found on farms of the type previously described, and in proportion to the crop area about twice the amount of live stock is carried. This live stock, of course, is mainly cattle and sheep. Fewer hogs are kept than on the other types of mountain farms. Wheat, oats, and buckwheat are the small grains usually raised. Beans and sweet potatoes are not raised to any great extent. Crop yields are notably higher than on the other farms described. Corn usually makes 25 to 40 bushels per acre, wheat 10 to 25 bushels, and oats 12 to 30 bushels per acre, whereas on the other types of small mountain farms corn generally yields 10 to 25 bushels per acre, wheat 5 to 10 bushels, oats 10 to 15 bushels, and rye 5 to 12 bushels. These higher yields, no doubt, are largely due to better soil and better farm practices. Here, for instance, sod land is frequently turned for corn, to be followed by small grain crops, while on the other farms described there is little or no attempt to rotate crops. The income from such farms is usually sufficient to support a family fairly well. Many families, however, must necessarily add to their income by labor off the farm.

OPPORTUNITIES FOR SPECIAL PRODUCTS.

In a few localities markets for farm products other than live stock and live-stock products have developed. In the vicinity of Chatta-

nooga, for instance, many mountain farmers have found it profitable to grow and market strawberries. In northwestern West Virginia, near the headwaters of the Potomac River, the growing of tomatoes for canning has developed to a considerable extent. In this same region the raising of peaches and apples is quite extensively developed even on the smaller-sized farms. On the high plateaus, especially in West Virginia and Tennessee, the growing of Irish potatoes is profitable where markets are within reach. In the vicinity of mining villages and towns, opportunities are afforded for the growing of a surplus of garden vegetables, orchard fruits, and various small fruits. The production of market milk and poultry products is also found to be profitable. Such special opportunities, however, are still very rare. The large majority of farmers in the mountains can not profitably market a surplus of perishable products, but must continue to depend almost wholly on live stock and certain concentrated forms of live-stock products, such as bacon, cheese, butter, and eggs, for cash income. Cattle and sheep may be driven long distances to market. Even hogs can be transported considerable distances on the hoof, and in some localities turkeys are driven in large flocks to market.

Mountain farmers, generally, are skilled in curing meats, especially bacon and hams, and at present prices the production and sale of these products should be profitable, even on farms located many miles from a railway. In some places navy beans have been grown with marked success, and at present prices they could profitably be hauled long distances to market.

This region has many advantages for the production of cheese. In some respects conditions are considered better than those of the principal cheesemaking centers of the United States, New York and Wisconsin. The summer climate is not usually excessively hot and springs are abundant. While many parts of the region are not well adapted to pasture grasses, yet a sufficient amount of pasture can usually be found for a few cows. For many years a few localities in this region have produced and sold a considerable amount of cheese and butter; and, as a rule, farmers engaged in this industry have much better crop yields and larger incomes than the average. Recently a few cheese factories operated cooperatively by farmers have been established in mountain communities, some of them far from market points. These have been remarkably successful. They were started under the general supervision of the Bureau of Animal Industry, United States Department of Agriculture. The cost of equipping one of these small factories rarely exceeds $1,000. This would cost 20 farmers $50 each. The plants must be supervised by persons skilled in cheesemaking, hence factories have not increased as fast as they otherwise would.

The raising of hogs fits in well and is made more profitable in connection with cheesemaking. The whey, a by-product in cheesemaking, is a valuable food, especially for sows and pigs. It is reported that in one mountain community hog production has increased tenfold since the making of cheese began.

SUGGESTIONS FOR BETTER MANAGEMENT.

The low yields on mountain farms are, as a rule, due more to the faulty cropping systems commonly followed than to poor soil. Crop rotations and the use of legumes for improving the soil are seldom practiced. Except to fertilize the garden, little use is made of stable

FIG. 2.—A cooperative cheese factory which was established in the mountains with the help of the Bureau of Animal Industry, United States Department of Agriculture. Hogs in the foreground feeding on whey. It is estimated that ten times as many hogs are raised here now as before the cheese factory was established. Ten pounds of whey have about the same feed value for hogs as 1 pound of corn.

manure. Clover, winter wheat, or rye are seldom used as winter cover crops. Except where the soil is unusually favorable, very small space is devoted to grass. Many small farms have no pasture or meadow, nearly all the crop land being devoted to corn and the garden.

Land which no longer produces well is commonly referred to as being "tired." The usual practice is to let such land lie idle for a few years to "rest" while the crop is shifted to a "rested" patch of ground which usually has grown up in young trees. This is especially the practice with corn, which exhausts the soil very quickly. Even in rich coves on mountain sides, three or four years of successive cropping makes the soil unprofitable for grain crops until "rested." Low bottom lands, which occasionally overflow, may be planted to

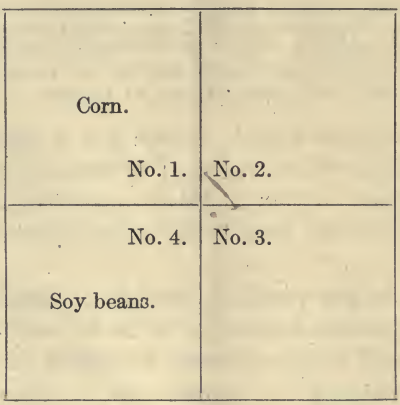
corn each year almost indefinitely without any reduction in yield. Only a few mountain farms, however, are thus fortunately situated.

By improving the cropping system, increasing the live stock, and using practical measures at hand for soil improvement, the mountain farmer can greatly increase production and maintain the fertility of the soil. At the same time opportunity is opened for a more profitable use of his own time and that of his family.

INCREASING YIELDS BY ROTATION.

Growing a different kind of crop on the land rests it as well as, or better than, letting it grow up to weeds. At the same time this practice brings the farmer more money, since it keeps the land busy raising crops all the time. When several crops are grown in this way the arrangement is called a "rotation," because the crops go around or rotate from field to field. Thus in a four-year rotation the land used for crops is divided into four fields, and each year for four years a different crop is grown on each field. The fifth year each field grows the same crop it grew the first year, and so on. The period of rotation may be two, three, four, five, or more years, depending on what farmers have found by experience to be the best practice.

Suppose a farmer wants to start a four-year rotation of corn, soy beans, rye, and clover. The first step is to provide four fields of about equal area. One arrangement of such fields is shown in the diagram below. Because rye is sown in the fall, and clover is sown on the same field the following spring, a full year before it is harvested, the rotation can not be started in full in one year.



Beginning in the spring of the first year, corn is planted in field 1, and soy beans in field 4. In the fall rye is sown on field 4, after the soy beans are harvested.

In the spring of the second year corn is planted in field 2, soy beans in field 1, and clover is sown on the rye in field 4. During the summer of the second year the fields will bear regular rotation crops as follows:

Soy beans. No. 1.	Corn. No. 2.
No. 4. Rye. (Young clover.)	No. 3.

In the fall of the second year rye is sown on field 1 after the soy beans are off.

In the spring of the third year corn goes in field 3, soy beans in field 2, and clover is sown on the rye in field 1. In the summer of the third year the crops are arranged as follows:

Rye. (Young clover). No. 1.	Soy beans. No. 2.
No. 4. Clover.	No. 3. Corn.

The rotation is now in full swing, the crops following each other around the circle in regular order.

During the summer of the first year fields 2 and 3 are not yet in the rotation and are available for any suitable crops or pasture. The same is true of field 3 during the second summer. These fields, of course, should not be planted in crops that will be in the way when they are needed in the rotation. Since field 2 is idle one year, none but a one-year crop should be grown on it. Field 3 does not come into

the rotation till the third year, so that it may be used either for an annual crop, such as corn, sorghum, potatoes, and the like, or for a winter grain, like wheat or rye.

After the rotation is fully established the succession of crops on the various fields is as follows:

Fourth year clover. Fifth year corn. Sixth year soy beans. Seventh year rye. Eighth year clover. Field 1.	Fourth year rye. Fifth year clover. Sixth year corn. Seventh year soy beans. Eighth year rye. Field 2.
Field 4.	Field 3.
Fourth year corn. Fifth year soy beans. Sixth year rye. Seventh year clover. Eighth year corn.	Fourth year soy beans. Fifth year rye. Sixth year clover. Seventh year corn. Eighth year soy beans.

This arrangement gives the same acreage of each crop each year, and does not bring the same crop on the same field oftener than once every four years. In this way each field, once every four years, gets the benefit of a crop of clover as well as of soy beans, both of which are good for the land.

Not only does following a rotation enable the farmer to grow more acres of crops and get better yields than he can when part of his crop land is lying fallow, but the practice enables him to save labor on some of his crops. If a cornfield has been kept clean by cultivation it is in good condition for a crop of small grain without further preparation. Grass and clover seed may be sown with the small grain, thus saving extra preparation of a seed bed. The grasses and clovers tend to improve the soil, counteracting the effects of the grain crops. Thus the land is "rested" while in continual and profitable use.

Usually in mountain farming the fields can not be laid out regularly, as indicated in the diagram above, since the tillable land generally lies in irregular patches here and there on the farm. The essential thing to do, however, is to put out each year on the various fields about an equal acreage of each of the rotation crops.

Generally it is not practical to follow without change a rotation plan, since various difficulties will arise to interfere with it. Sometimes, for instance, clover or grasses will fail to make a stand, in which case a second attempt may have to be made. For special reasons it may be best to increase the corn acreage one year or make less another, and so on with other crops; but the general rotation

plan should always be kept in mind and followed as nearly as possible.

Some mountain farmers have demonstrated the value of improved methods which make more intensive use of the land, and not only maintain its fertility under continuous use, but increase crop yields much beyond those of newly cleared lands.

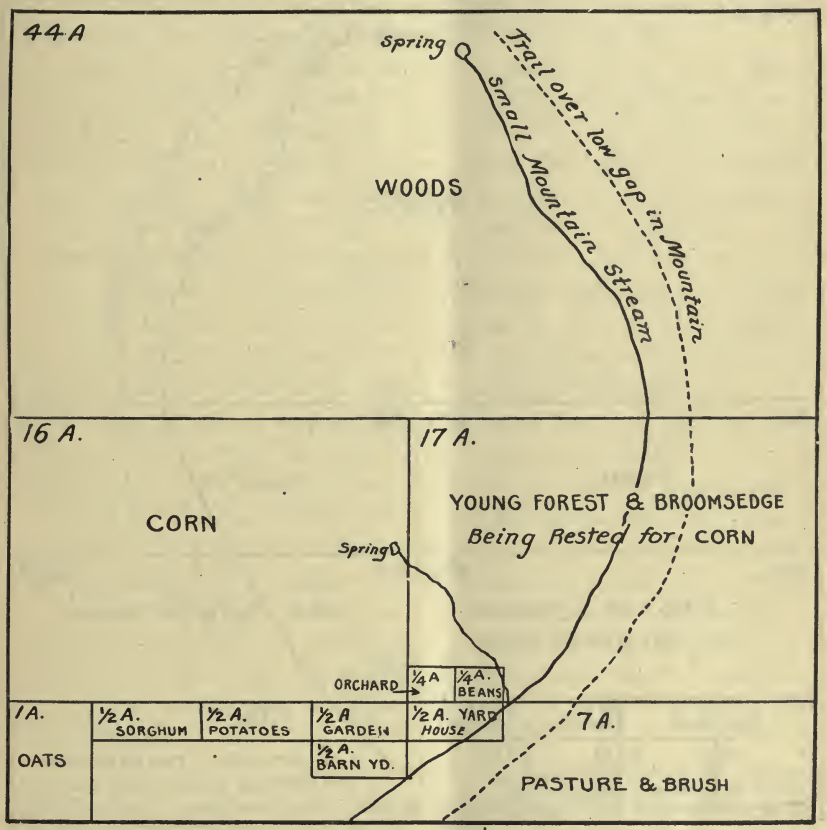


FIG. 3.—Approximate proportion of land in various crops and in woods on an 88-acre farm in the rugged mountains of eastern Kentucky. This arrangement is typical of the way in which land is utilized by farmers in the southern Appalachians.

CROPPING SYSTEM ON A TYPICAL FARM.

The usual cropping system on an 88-acre mountain farm which has been run for many years is shown by the diagram in figure 3. The total yearly production of corn has been about 250 bushels, oats 15 bushels, Irish potatoes 40 bushels, sorghum molasses 50 gallons, honey 40 pounds, and beans about 2 bushels. The garden ordinarily supplies about 30 bushels of sweet potatoes, besides peas, onions, and other common summer vegetables.

Managed in this way the farm can carry one or two cows, two or three young stock, and a sow with five or six pigs. Several sheep,

which live mainly on pasture in the woods and waste places, are usually kept. One horse could do the work on the farm, but two horses and a wagon are kept to haul ties, lumber, posts, or provisions, besides doing the farm work. It is readily seen that a farm managed in this way can supply only the bare necessities for a family

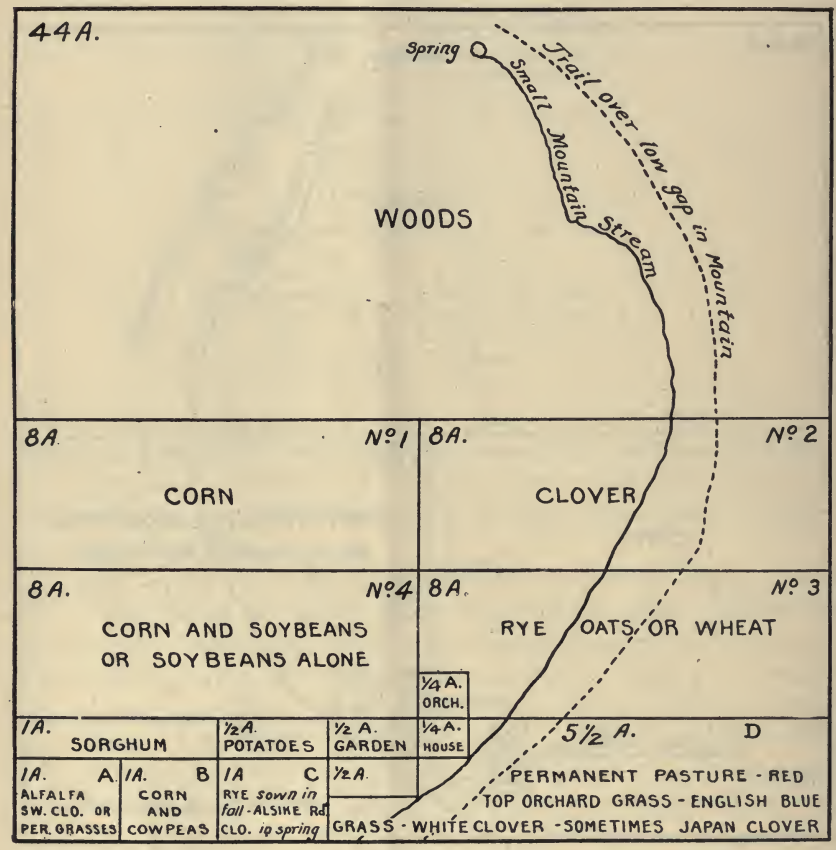


FIG. 4.—A better cropping system for the farm shown in figure 3. The fields are arranged for a four-year rotation of (1) corn, (2) soy beans, (3) small grain, and (4) clover. The fields of course, can not, as a rule, be uniform in shape or size, as are the fields shown in the diagram, but, even when the tillable land is in scattered patches, they can be handled so that there will be approximately equal acreages of crops each year.

of eight persons. It is impossible for anything to be left over for the support of community interests or to educate the children properly.

REPLANNING FOR PROFIT.

Without any increase in the tillable area, such a farm can be managed so as to yield a more satisfactory living and something besides. The diagram in figure 4 shows a possible rearrangement of

the cropping system on this farm. The suggestions given are based on the experience of practical mountain farmers.

Instead of relying on shifting the corn field to new or "rested" land every few years in order to maintain even a low yield, provision is made for a rotation which keeps all the improved land continually in crops and at the same time increases yields. The diagram shows a four-field system to be run in a four-year rotation. This is substantially the rotation already outlined on page 10.

Field No. 1 is plowed in the fall or early spring, to be planted to corn. Field No. 4 is plowed in the spring and planted to corn and soy beans. In some cases it might be advisable to plant the whole field to soy beans. Some farmers plant this crop in alternate rows with the corn. It is also a common practice to plant cowpeas in the same rows with the corn. This practice is especially advisable when the crop is to be hogged off or if the corn is to be put into a silo. Field No. 4 (after the soy beans are harvested) could be sown to rye in the fall and to clover in the early spring of the second year. Or such a field could be sown partly to rye or wheat and partly to oats if either of these crops could be utilized profitably.

In the spring of the second year field No. 2 is plowed for corn. Corn and soy beans or soy beans alone are planted in field No. 1, where corn grew the first year, and clover is seeded on the grain crop in field No. 4. After this grain crop has been cut, the clover comes on and is available for fall pasture. In the fall, rye or wheat is sown on field No. 1 after the soy beans have been harvested.

The next spring (third year) field No. 3 is plowed for corn, field No. 2 (corn stubble) is planted to corn and soy beans or to soy beans alone, and clover is seeded on the rye in field No. 1. Field No. 4 is in clover, which may be cut for hay in late June or early July, or pastured.

The next spring (fourth year) the clover stubble is plowed for corn and the rotation is fully established. The fifth year corn will get back to field No. 1, where it started the first year, and a new rotation will be begun.

Rye may be used in several different ways. It makes good early winter pasture, especially for sheep. It is also better for the land than oats, because it provides a winter cover crop, thus keeping the soil from washing. It may be harvested for hay or for grain, or it may be hogged off.

When the land is brought to a good state of fertility by such a rotation, hairy vetch may be sown with the rye in the fall, thus increasing its value as hay, pasture, or as a grain crop. Rye and vetch mature at about the same time, and they may be thrashed together, the grain making excellent feed for stock. On rich soil, Canada field peas may be sown on the unbroken surface, plowed

under 4 or 5 inches deep, then the ground sown with spring oats. This combination considerably increases the value of the crop for hay or for hogging off.

Besides the general field crops in the four-year rotation, provision is made for pasture for hogs. This is an important feature in the farm plan, especially where hogs are depended upon for the principal cash sales.

Hogs are most cheaply raised when they can be furnished considerable pasture, this being especially important for sows with pigs. A good pasture scheme for hogs should provide a succession of crops in addition to some kind of permanent pasture. Each field should be fenced hog tight and be accessible to water.

The scheme in figure 4 provides three fields of one acre each. Corn and cowpeas and rye with clover are planted in a two-year rotation. For instance, field B, after being hogged down in the fall, is sown to rye. In the early spring, February or March, red clover is sown. The best time is when the ground is freezing or thawing, or when the clover seed may be harrowed in without injury to the rye. The rye may be pastured a short time in the early spring, after which the hogs may be turned into field A in permanent pasture until the rye is sufficiently matured to hog down, when they may go into field C. Thus they may be shifted from one field to another, and sometimes to other fields on the farm, especially the clover field shown in the diagram as field No. 4.

Such a hog pasture when brought up to a good state of fertility should provide sufficient pasture for 15 to 20 hogs. To bring them to 200 or 250 pounds weight, 200 to 250 bushels of corn or its equivalent would be needed, in addition to the pasture. The cropping system as outlined should easily provide this amount of corn for the hogs. When there is "mast" in the woods, additional hog feed is available which to a large extent may be substituted for corn. Instead of 18 bushels per acre, the usual yield under the old system of farming, at least 35 bushels of corn per acre should be produced, giving 560 bushels for the farm, a quantity sufficient for the needs of the family and for the increased number of live stock.

The permanent pasture for hogs is an important feature in the plan for hog raising. This can be used at any time when the other fields are not ready to pasture, or if for any reason it is not advisable to pasture them.

Alfalfa makes an excellent permanent pasture and is recommended, especially where a considerable area of bluegrass or other pasture grasses is not available. The land on which alfalfa is to be sown should be well manured and limed. If it is impossible to haul lime to the farm, or if it can not be burned in the vicinity or on the farm, wood ashes, which are sometimes available, may be used instead. To

get the best results, 2 to 3 tons of wood ashes should be used on an acre. Brush, old logs, and leaves, where available, may be burned on the land, thus greatly improving the soil for alfalfa.

The preparation of the seed bed for alfalfa should be begun early in the season. The land should be worked frequently with a harrow and hoes during the summer to keep down weeds which take up the moisture. The seeding may be done late in August or early in September.

It will be necessary, in order to get a good stand of alfalfa, to inoculate the soil with soil from another alfalfa field, or to inoculate the seed with material which can be bought from fertilizer and seed dealers, or can be obtained free in small quantities from the United States Department of Agriculture.

Sweet clover is an excellent pasture plant for hogs, and may be sown in place of alfalfa. If given the opportunity, it will reseed itself each year, while the alfalfa plant holds the ground year after year indefinitely. The two often grow well together and may be sown in a mixture, the requirements in soil preparation and inoculation being the same for each. As a rule, however, better results are obtained with sweet clover by sowing in the spring than in the summer or fall.

On well-limed, rich soil bluegrass makes a good permanent pasture. In some places bluegrass and sweet clover have done well together. On soils not adapted to Kentucky bluegrass, a mixture of red top, orchard grass, English bluegrass, white clover, and alsike makes a good permanent pasture for hogs. In some localities Japanese clover may be added.

The new arrangement, as indicated in figure 4, provides 5½ acres of permanent pasture which may be used for cattle, sheep, or possibly for hogs at times. Besides this, considerable pasture is available from clover, as shown in field No. 2. Bluegrass makes the best permanent pasture for cattle, sheep, or horses where the soil will grow it without special preparation. On most mountain farms, however, Kentucky bluegrass does not grow well, the pasture grasses well adapted to mountain soils being red top, orchard grass, and English bluegrass.

This farm, rearranged, should carry at least three cows and three to five young stock—calves, yearlings, and 2-year-olds. It may often be profitable to keep several sheep to clean up the wastes about the farm and to pasture winter grain. Sheep are light in weight and do not injure the fields to any extent when the ground is soft. They will eat the weeds and tender tree sprouts which tend to crowd out pasture grasses. Turned in a field of winter rye, wheat, or oats after clover seed is sown, they will tramp in the seed, thus practically insuring a stand.

Cows can be made more profitable on mountain farms if there is opportunity for cheese production. (See page 8.) It has been found profitable to market cheese at long distances from market. Two or three hundred pounds may be carried on the back of a horse or mule. Cheese, as well as bacon and other pork products, now has a high value per pound, making it a highly profitable product for mountain farming. The high food value of these products in proportion to their weight and their keeping quality make them readily marketable in any part of the world where they are used for food. As was previously stated, the cheese industry is being rapidly developed in parts of the lower Appalachian Mountain region, and mountain farmers generally are advised to give it careful considera-

FIG. 5.—A type of the better mountain farmhouse. This is the home of the owner of a small mountain farm on the Cumberland Plateau in Tennessee. With little added expense any farmhouse can be built to present a neat and pleasing appearance, and ivy, vines, and shrubs to beautify the yard can be planted and grown practically without cost.

tion. Pork production fits in well also with cheese production, because hogs utilize to good advantage the whey, a by-product of cheese making.

It will be seen that no change is made in the usual plan for the home garden and for raising such crops as potatoes, beans, and sorghum for home use. The present arrangement is about as good as any that could be suggested. The sorghum patch may frequently be increased, however, with profit, since, besides being utilized for making molasses, it is an excellent forage crop for stock. An extra half acre could be used to good advantage for this purpose.

A farm such as this, even though it can not reach a market by wagon road, may profitably market its surplus products, which

would be live cattle, cured meats, cheese, if a factory were available, and possibly a few lambs. Instead of a cash income of $100 to $200, the most that could be expected from such a farm under the old way of management, under the new system, without an increase in the tillage areas or a change in market facilities, the farm should have a cash income of not less than $500 to $800, which would make possible a much higher standard of living than that under the old system. (See fig. 5.)

In many cases the owner could continue seasonal work in lumbering, in hauling, or in the coal mines, while others of the family could do successfully most of the necessary farm work. The new system need not interfere to any extent with any home industries already

FIG. 6.—This is a mountain corn-club boy preparing a seed bed for corn. One-horse implements are common on mountain farms.

established, such as spinning, weaving, and making baskets and furniture, and does not necessitate any increase in number of work stock kept.

IMPORTANCE OF MANURE.

The rotation of crops as outlined can not be depended upon alone, however, to increase and maintain crop yields. The soil must be kept abundantly supplied with vegetable matter for humus, such as manure, cornstalks, straw, leaves, and such crops as rye, clover, and cowpeas plowed under. Grass, because of its extensive root system, is an important crop for putting organic matter into the soil. This is probably the main reason why good crops are usually obtained after breaking a well-sodded meadow or pasture.

For general farm purposes, stable manure is the best fertilizer known, since it contains all the essential plant foods and is instrumental in making more available the plant foods already in the soil. It is, therefore, of the greatest importance that the manure produced

on the farm be well taken care of and scattered on the land where needed. Manure should not be left to waste out of doors, but when possible taken from the stables each day and applied directly to the land. When this can not be done it should be piled under cover until it can be properly used.

The mountain farmer who can till but a small portion of his land will find it exceedingly profitable to take particular care not only of the manure but of all waste vegetable matter which may be put into the soil to make humus. Waste straw, fodder, and hay, even leaves from the trees in the woods, may be gathered and used for bedding for animals, thus increasing the amount of manure. These are often profitably utilized in making compost, which is simply rotted ma-

FIG. 7.—Where deep plowing is desired it frequently is necessary to use all the work stock on the place in one team.

nure and waste vegetable materials such as have been described mixed with earth. This material is especially good for garden fertilizer.

A compost heap is made by piling manure, various refuse materials, and earth in alternate layers, to be left until the coarse matter is well rotted. The sides of the pile should be built up perpendicularly, the center and the top being kept about level, so that rain falling on it will be absorbed to keep the material moist. In a year or two after the process is started the compost will be ready for use on the garden. There should be at least two compost piles on each farm, so that one pile will be available for use each spring.

On such a farm as that first described (p. 14) there should be sufficient manure, if properly cared for, to cover one of the 8-acre fields each year, besides enough for the garden and other small areas devoted to special crops.

The drainage of the land is another matter to be looked after. Crops will not do well unless water drains readily beneath the surface. During the wettest times water should not stand within less than 2 or 3 feet from the surface.

On most mountain farms with but small areas of cultivated land, the most practical way to drain the land is usually by digging ditches 2½ to 3 feet deep and filling in several inches with stone, or by laying in the bottom of the ditch 3 or 4 poles or small logs and covering them with brush, grass, or leaves before filling in with soil. Of course an outlet must be provided and enough slope given in the bottom of the ditch to permit the water to run off readily. Where drain tile is available and the farmer can afford it, this should be used instead of stone and logs.

Often during wet weather the water comes to or near the surface on high ground, frequently even near the top of a hill or mountain, forming a spring that keeps a considerable amount of land around it wet. This condition can often be prevented by digging a ditch above and around the wet area in such a way as to drain the water entirely off this ground.

Where stones lie loose or imbedded in the soil good use can be made of them by putting them into drainage ditches, or using them to build fences or dams to prevent washing.

The location and arrangement of fields and the way of planting crops are important matters in mountain farming. The title-page picture illustrates an ideal practice for many steep mountain farms. The tillable land is located around the base of the mountain. The forest above breaks the force of water flowing down after heavy rains or the melting of snows. The frequent flowing of water from this wooded area brings with it vegetable matter and plant food from the forest area above. The rows are planted in curves around the hills instead of up and down. These rows, one above the other, form narrow terraces, which break the force of water as it flows down the hill. This practice greatly lessens the danger of washing, one of the main difficulties in farming steep mountain land. The sandstone and shale soils, however, are much less liable to bad erosion than even the more level limestone soils. The reason seems to be mainly the fact that these steep mountain lands usually have a loose subsoil and a stony top soil that permits rapid absorption of water, thus lessening the force of the flow on the surface.

Nearly all mountain soils are benefited by lime, but most of them are situated so that it is not practicable to haul lime from market points, and in a large majority of cases there is no limestone in the vicinity for producing it. As previously stated, wood ashes may take the place of lime, but ashes are not available in sufficient quantities to cover any but small areas. One or two thousand pounds of burnt

lime per acre applied to the land every four to six years will greatly increase crop yields, and it would pay farmers to haul it quite long distances and apply it to their lands. It is especially beneficial for clover, practically insuring a stand and vigorous growth. Figure 8 shows how farmers burn lime when the limestone is available. Figure 9 shows a method of spreading lime evenly over the ground.

Crops also are usually benefited by the use of commercial fertilizers, especially acid phosphate, which, on such grain as rye, wheat, or oats, may be applied at the rate of 200 to 250 pounds per acre. When plenty of stable manure and various kinds of refuse vegetable matter on the farm are available and put into the soil

FIG 8.—A mountain farmer constructing a limekiln preparatory to burning. Wood is piled at the bottom of the kiln and a flue put up through the center so as to permit a draft when the fire is started. A space filled in with kindling usually extends lengthwise underneath the pile, and the fire is started at one end. The chinks between the logs are filled in with small sticks, cornstalks, or other trash, to make the fire start easily. When coal is used, there are usually alternate layers of fine coal and limestone, 2 or 3 inches of coal and 4 or 5 inches of stone, the pile being drawn into a peak at the top 7 or 8 feet high. Wood alone is often used.

other fertilizers, such as nitrogen and potash, are not needed. All legumes, such as clovers, peas, and beans, are especially valuable for the soil, since they supply nitrogen obtained from the air. If the soil is very poor and needs especially nitrogen and organic matter, a crop of cowpeas is one of the best crops to begin with. The whole crop should be turned under, however, in order to get full benefit from it.

IMPROVING THE MANAGEMENT OF A SMALL GRAZING FARM.

The distribution of acreage shown on page 24 illustrates the usual practice on the grazing type of small mountain farm, a type most

common on the high mountains and plateaus in West Virginia and in some other places similarly situated. These farms are largely in meadow and pasture, and a relatively small area is devoted to corn. The yield of corn, however, is usually higher on these farms than on mountain farms farther south in Kentucky and Tennessee. This is explained by the facts that the richest portions of the farm are selected for the corn and that it is a frequent practice to turn sod for corn.

Without increasing to any extent the amount of cultivated land or changing the type of farming, the income on these farms can be greatly increased by a more systematic rotation of crops, better utilization of manure and other by-products usually wasted, and better care and utilization of pasture lands.

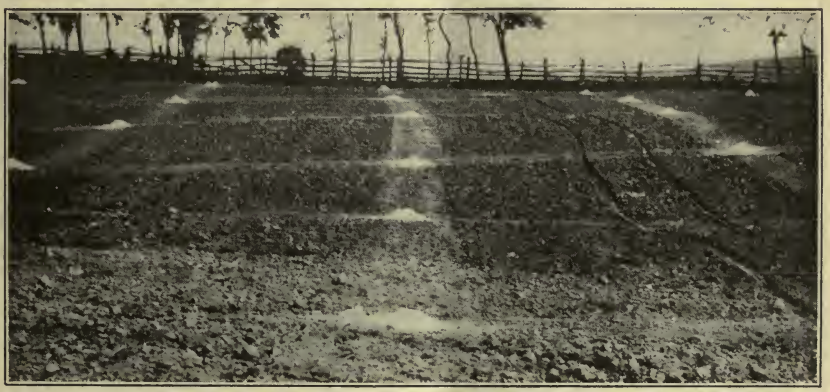


FIG. 9.—This shows a common method of spreading lime. It is not the best method for large or medium-sized farms, but it is recommended for small farms on which it does not pay to keep a lime spreader. Squares are marked off on the field about 1,742 square feet in size, or a little less than 42 feet on a side. One bushel of lump lime, or its equivalent, about 2 bushels of air-slaked lime, placed at each intersection of the marks and scattered evenly, will put on the land about 1 ton of burnt lime per acre.

Figure 10 shows how the crops should be proportioned on such a farm to establish a more systematic rotation. Usually as much of the farm as can be developed into permanent pasture without too much expense, on land which is not suitable for cultivation, should be used for grazing. The land that can readily be brought under cultivation should be put into crops and handled in as regular a rotation as possible. In this rotation a clover and grass crop should hold the land at least one or two years for meadow or pasture.

At least three acres should be devoted to a succession of crops for hog pasture. This would enable the farm to carry more hogs and make it possible to raise them at low cost. Bacon and other cured pork products, at present prices, would find a profitable market, even though the farm is a long distance from the nearest railway point. These products also will find a ready sale in near-by mining towns.

In this pasture rotation for hogs, corn would be followed by oats in the spring. Canada field peas may be sown before this ground is plowed, turned under four or five inches deep, and oats sowed and harrowed in, thus greatly increasing the amount of feed produced on the land. This is good practice, especially where the oats are to

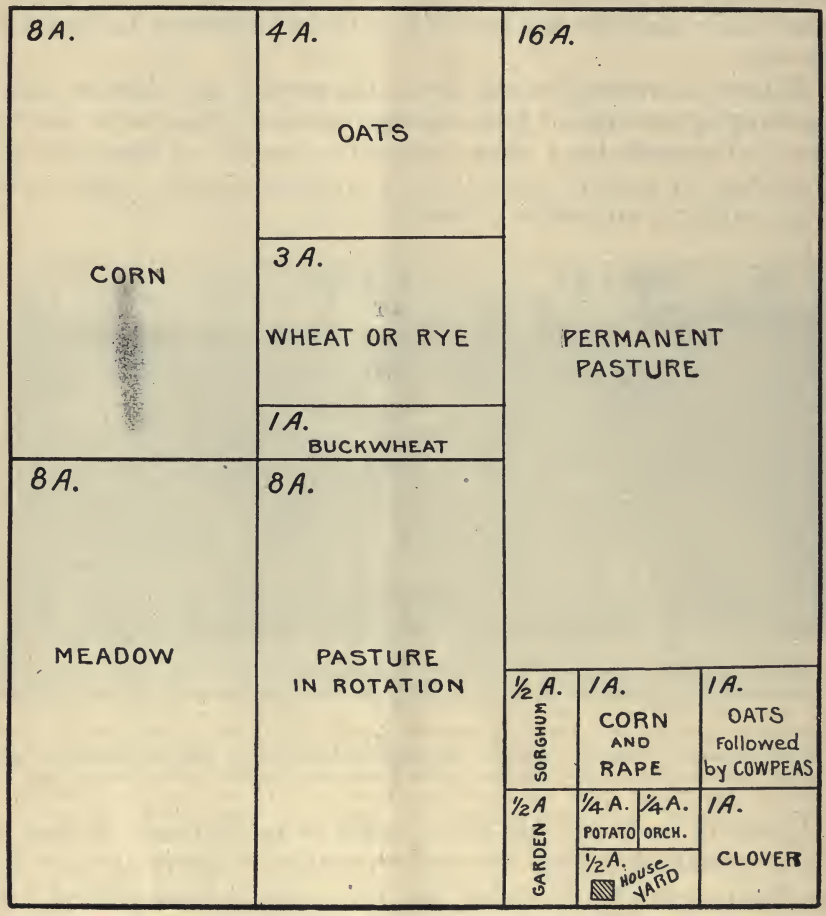


FIG. 10.—This shows good selection of crops for a small mountain farm on the high plateaus where pasture grasses do well and where oats and wheat are well adapted. Usually such a farm will have an untillable wooded area equaling or exceeding the area which can be used for crops and permanent pasture. As a rule the tillable areas are scattered here and there on the farm, making it difficult to divide it into regular fields. However, it is possible always to keep the acreages of each crop about the same each year, so that such a four-year rotation as is suggested in the diagram can be followed with reasonable regularity. For other practical rotations, see p. 26.

be cut for hay or hogged off. Red clover should be sown with the oats. This will make good fall pasture after the oats are off, as well as regular summer pasture the next year. The clover sod should be turned late in the fall of the second year for corn the next spring. Cowpeas or soy beans may be planted with the corn. Cowpeas should be planted in the same row with the corn, to climb up the

stalks. Soy beans, which do not climb, should be planted either in alternate rows with corn or alone in part of the field, and cultivated the same as the corn. At the last cultivation of the corn, rape should be sown broadcast between the rows of corn, to furnish green pasture for hogs. Water should be available for hogs in each of the three fields. A permanent pasture should also be available nearby. This may be an alfalfa field of an acre or two or several acres of bluegrass or other pasture grasses adapted to the soil. Sweet clover is also an excellent hog pasture and may be used instead of alfalfa. For preparing the land for alfalfa or sweet clover see page 17.

Sheep may assist in utilizing these pasture crops. These animals will make good use of the crops usually left to waste by hogs. Rape sown at the last cultivation of the corn in the regular field rotation may be pastured by sheep late in the fall. This, together with pasture on winter wheat, would enable such a farm to keep more sheep than usual. Instead of oats, wheat, and buckwheat occupying one of the 8-acre fields, the entire area might in some cases be sown to rye and hairy vetch at the last cultivation of corn. This would furnish late fall, early spring, and summer pasture for sheep. This would be a good scheme of management for those wishing to specialize in sheep. The lambs pastured on such a crop would be in excellent shape for the July and August market.

A farm rearranged and improved as above described should carry 4 to 5 cows, 8 to 12 young cattle, 2 or 3 brood sows with at least 15 to 20 pigs a year, and 15 to 20 ewes. Cheese making would be a profitable industry on these farms. In fact, conditions ought to be more favorable for cheese making here than in situations where pastures are more difficult to maintain. In one county in northern West Virginia, the value of cheese produced and sold in 1910 was about $34,000. Only a few counties produce any cheese at all, but the industry should be extended in all mountain counties, especially where markets are difficult to reach. For cheese production, the silo will be found a profitable investment on many farms.

Instead of the plan of rotation shown in figure 10, the following rotation might be considered on these small grazing farms:

First year	Corn, with rape and rye sown at last cultivation.
Second year	Buckwheat, rye, and vetch, in the same proportions as in figure 10, with red clover and grass sown in early spring.
Third year	Clover and grass.
Fourth year	Clover and grass.

Where a market is available for Irish potatoes, these may take the place of part of the corn land in this rotation. Rye and vetch may be sown with the buckwheat if the land is sufficiently fertile

and the season favorable. Grass seed should be sown with the grain crops. This system would greatly increase the amount of pasture without greatly increasing the amount of grain production.

OTHER PRACTICAL ROTATIONS.

Some farmers may find it more desirable and practical to follow rotations somewhat different from those already described. For this reason two more simple and practical rotations are suggested.

A FIVE-YEAR ROTATION SUITED TO A MEDIUM-SIZED GENERAL FARM.

First year	Corn, followed by winter cover crop of rye or pasture and green manure.
Second year	Cowpeas or soy beans.
Third year	Rye or other small grain.
Fourth year	Clover and grass.
Fifth year	Clover and grass.

This rotation is recommended by the Tennessee Agricultural Experiment Station for general farming on the Cumberland Plateau and has been in favor with many thousands of farmers.

On a medium-sized farm of at least 50 to 60 acres of crop land, this is an excellent rotation, especially for the more southern part of the region. Here, generally speaking, a 5-year rotation is considerably better than a 3-year or 4-year rotation. On a farm with only 25 to 30 acres of land available for crops, the rotation might not furnish enough grain in proportion to meadow and grass. In any case, however, the condition of soil and the type of farming to be followed would need to be taken into consideration. A small dairy farm, for instance, could utilize the meadow and pasture to great advantage, and such a type of farming would soon build up the land so that the increased yield of grain would offset the smaller acreage in such a rotation. A small hog farm, on the other hand, would, as a rule, be more profitable with a shorter rotation and more feedable grains.

In places where Irish potatoes do well, and where there is a market for them, these could take the place of clover and grass in the fifth year. In that case a cover crop should follow potatoes. Crimson clover, where it thrives, would be excellent for this purpose. Otherwise rye should be used.

A FOUR-YEAR ROTATION WELL ADAPTED TO SMALL MOUNTAIN FARMS.

First year	Corn.
Second year	Sorghum for forage.
Third year	Spring oats.
Fourth year	Clover and grass.

This rotation also is recommended by the Tennessee station for mountain farming on the Cumberland Plateau. It has been successfully used by mountain farmers in Tennessee and is well adapted to thin soils.

In high, cold places, and where the soil is fairly good, oats might take the place of sorghum in the second year. In many cases Canada field peas could be sown with the oats. This practice would add greatly to the value of the crop if cut for hay or if it is to be hogged down.

Rape, instead of Canada peas, could be sown with the oats. This crop would provide pasture for hogs or sheep after the oats are harvested and before the clover and grass are ready to be pastured. Clover and grass, of course, would be sown with the oats early in the spring.

Where buckwheat is grown successfully, as on the high plateaus of West Virginia, the following four-year rotation would succeed very well:

First year	Corn, or partly corn and potatoes.
Second year	Spring oats and Canada field peas, cut for hay or hogged off, and followed by buckwheat, with which clover and grass are seeded.
Third year	Clover and grass.
Fourth year	Clover and grass.

When it is desirable to thrash some oats the farmer can sow a part of the field to spring oats alone, sowing clover and grass seed early in the spring with the oats. This plan provides grass and clover on the entire field the second year.

USEFUL PUBLICATIONS.

The following bulletins published by the United States Department of Agriculture and the State experiment stations should be helpful in establishing better farming in the Southern Allegheny Mountains. Most of these bulletins may be obtained free of charge.

AVAILABLE FOR FREE DISTRIBUTION BY THE U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

Sweet Clover; Growing the Crop. (Farmers' Bulletin 797.)
Killing Hogs and Curing Pork. (Farmers' Bulletin 913.)
Home Canning. (Farmers' Bulletin 839.)
Home Canning of Fruits and Vegetables. (Farmers' Bulletin 853.)
Drying Fruits and Vegetables in the Home. (Farmers' Bulletin 841.)
How to Make Cottage Cheese on the Farm. (Farmers' Bulletin 850.)
Neufchâtel and Cream Cheese: Farm Manufacture and Use. (Farmers' Bulletin 960).

EXPERIMENT STATION BULLETINS.

Rational Improvement of Cumberland Plateau Soils. (Bulletin 101, Tennessee Experiment Station, Knoxville, Tenn.)
Rational Improvement of Highland Rim Soils. (Bulletin 102, Tennessee Experiment Station, Knoxville, Tenn.)
Fertility Experiments in a Rotation of Cowpeas and Wheat. (Bulletin 96, Tennessee Experiment Station, Knoxville, Tenn.)
Liming of Tennessee Soils. (Bulletin 97, Tennessee Experiment Station, Knoxville, Tenn.)
Lime for Virginia Farms. (Bulletin 187, Virginia Experiment Station, Blacksburg, Va.)
Alfalfa and Sweet Clover. (Bulletin 178, Kentucky Experiment Station, Lexington, Ky.)

IN THE FIELD of agriculture we have agencies and instrumentalities, fortunately, such as no other government in the world can show. The Department of Agriculture is undoubtedly the greatest practical and scientific agricultural organization in the world. Its total annual budget of $46,000,000 has been increased during the last four years more than 72 per cent. It has a staff of 18,000, including a large number of highly trained experts, and alongside of it stand the unique land grant colleges, which are without example elsewhere, and the 69 State and Federal experiment stations. These colleges and experiment stations have a total endowment of plant and equipment of $172,000,000 and an income of more than $35,000,000 with 10,271 teachers, a resident student body of 125,000, and a vast additional number receiving instructions at their homes. County agents, joint officers of the Department of Agriculture and of the colleges, are everywhere cooperating with the farmers and assisting them. The number of extension workers under the Smith-Lever Act under the recent emergency legislation has grown to 5,500 men and women working regularly in the various communities and taking to the farmer the latest scientific and practical information. Alongside these great public agencies stand the very effective voluntary organizations among the farmers themselves which are more and more learning the best methods of cooperation and the best methods of putting to practical use the assistance derived from governmental sources. The banking legislation of the last two or three years has given the farmers access to the great lendable capital of the country, and it has become the duty of both of the men in charge of the Federal Reserve Banking System and of the Farm Loan Banking System to see to it that the farmers obtain the credit, both short term and long term, to which they are entitled not only, but which it is imperatively necessary should be extended to them if the present tasks of the country are to be adequately performed. Both by direct purchase of nitrates and by the establishment of plants to produce nitrates, the Government is doing its utmost to assist in the problem of fertilization. The Department of Agriculture and other agencies are actively assisting the farmers to locate, safeguard, and secure at cost an adequate supply of sound seed. The Department has $2,500,000 available for this purpose now and has asked the Congress for $6,000,000 more.—*From President Wilson's Message to Farmers' Conference at Urbana, Ill., January 31, 1918.*

2nd.

THE SELF-FEEDER FOR HOGS

F. G. ASHBROOK and R. E. GONGWER

Animal Husbandry Division

Young Pigs Soon Learn to Eat from the Self-Feeder.

FARMERS' BULLETIN 906

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry

A. D. MELVIN, Chief

Washington, D. C. December, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

WITH the ingredients of a good ration constantly before them, placed so that they may eat at will, hogs will make gains more rapidly and more economically than when fed by hand. The time needed to bring them to a certain weight will be shortened and the labor of feeding them will be reduced. Results of experiments proving these facts are stated briefly in this bulletin, and plans for constructing self-feeders of several kinds are given, together with lists of materials needed.

THE SELF-FEEDER FOR HOGS.

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WHAT THE SELF-FEEDER IS.

THE USE OF SELF-FEEDERS for fattening hogs is gaining in popularity. A self-feeder is simply a device by means of which a supply of grain or other feed is kept constantly available to the hogs, in order that they may always satisfy the craving of their appetites with respect to the kind and the amount of feed.

Hogs in the wild state were self-fed animals, living upon such feeds as would satisfy their appetites, and under domestication they seem to thrive best when fed by the same principle. The marked success of the self-feeding system of hog raising is largely due to the fact that they may eat an abundance of those feeds which will nourish them to the best advantage.

EXPERIMENTAL DATA.

In order to determine whether the system of self-feeding may be applied to the fattening of pigs, numerous experiments have been conducted in recent years comparing similar lots of pigs when hand-fed and when self-fed upon the best rations known to hog raisers.

The United States Department of Agriculture conducted two tests with the self-feeder at the Experiment Farm at Beltsville, Md. These tests are by no means conclusive in themselves, but when considered in conjunction with similar tests made at several State experiment stations, with their preponderance of corroborative data, it is safe to rely upon some general facts which are clearly shown.

EXPERIMENT 1.

Experiment 1, with 18 grade Berkshire pigs, from February 22 to May 2, 1916, was conducted to compare the relative fattening efficiency of a ration of corn meal, middlings, and tankage when hand-fed and when self-fed. The pigs were kept in dry lot. The hand-fed

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lot was fed three times daily, the amount being governed by the appetite, while the self-fed pigs had free access at all times to the three feeds placed in separate compartments of the self-feeder. The results obtained are contained in the following table:

TABLE 1.—*Comparison of hand feeding with the use of a self-feeder.*

Item.	Lot 1 (hand-fed): Corn meal 5 pounds, middlings 4 pounds, tankage 1 pound.	Lot 2 (self-fed): Corn meal 19 pounds, middlings 2.83 pounds, tankage 1 pound.
Number of pigs	9	9
Days on experiment	70	70
Total initial weight.....pounds..	850	829
Total final weight.....do....	1,507	1,847
Total gain.....do....	657	1,018
Average daily gain per head.....do....	1.04	1.62
Total feed.....do....	2,694.5	4,138
Daily ration in percentage of live weight.....per cent..	3.27	4.42
Feed per 100 pounds gain.....pounds..	410.1	406.4

Results.—Table 1 shows that the self-fed pigs in lot 2 gained much more rapidly by consuming a larger daily ration in proportion to live weight than did the hand-fed pigs in lot 1, but that this more rapid gain did not require any more feed in proportion to the gains in live weight. In fact, the self-fed pigs required a little less feed to gain 100 pounds in weight, than was required for lot 1, hand-fed.

EXPERIMENT 2.

Experiment 2, with 10 grade Berkshire pigs, from April 3 to May 1, 1917, was conducted to compare the value of corn meal with that of shelled corn for use in the self-feeder. Both lots had access to tankage in a separate self-feeder. The pigs averaged about 90 pounds in weight, and had the run of an excellent rye pasture. For means of comparison the data on a hand-fed lot (lot 3) are inserted. These pigs were exceptionally well grown, of the same breeding, a little older at the time of the experiment than were the pigs of lots 1 and 2, and grazed in a more nutritious pasture, rape. They were fed all they would consume of a balanced ration of corn meal, middlings, and tankage. Although lot 3 was fed in the fall of 1916, conditions were very similar to those for the self-fed pigs, and any possible advantage was in favor of lot 3. The results obtained are contained in the following table:

TABLE 2.—*Comparison of corn meal with shelled corn for use in the self-feeder.*

Item.	Lot 1 (self-fed): Rye pasture, corn meal 38 pounds, tankage 1 pound.	Lot 2 (self-fed): Rye pasture, shelled corn 16.3 pounds, tankage 1 pound.	Lot 3 (hand-fed): Rape pasture, corn meal 5 pounds, middlings 4 pounds, tankage 1 pound.
Number of pigs	5	5	5
Days on experiment	28	28	35
Total initial weight...pounds..	431	444	695
Total final weight...do....	657	658	954
Total gain...do....	226	214	259
Average daily gain per head...do....	1.61	1.53	1.48
Total feed...do....	820	710	956
Daily ration in percentage of live weight...per cent..	5.39	4.60	3.31
Feed per 100 pounds gain...pounds..	362.8	331.7	369.1

Results.—Lot 1, self-fed on corn meal and tankage, made slightly more rapid gains than lot 2, self-fed on shelled corn and tankage, and both gained more rapidly than lot 3, hand fed on corn meal, middlings, and tankage. Lot 1, however, required 31 pounds more grain than lot 2 to produce 100 pounds of gain. The most expensive gains were made on lot 3 (the hand-fed lot), where 369.1 pounds of mixed feed were required to produce 100 pounds of gain in live weight. The gains were very profitable on all lots, but shelled corn and tankage, self-fed, produced the best results.

In themselves these tests are of small importance, but as the results are very similar to those obtained in experiments conducted at a number of State agricultural experiment stations they may be considered as fairly representative.

TOTAL EXPERIMENTAL RESULTS.

A compilation has been made of the results obtained with the self-feeder at numerous experiment stations in this country, and an average of all is contained in the following table:

TABLE 3.—*Average results with self-feeders at experiment stations.*

Number of pigs.	Method of feeding.	Average days fed.	Average daily gain per head.	Average daily feed per head.	Average amount of feed per 100 pounds of gain.
			Pounds.	*Pounds.*	*Pounds.*
262	Hand-fed	82.2	1.23	5.47	445
332	Self-fed	68.5	1.92	8	417

These results, obtained upon nearly 600 pigs, show clearly that more rapid gains are obtained with the self-feeder than by the best of hand-feeding methods, partly owing to the larger daily con-

sumption of feed per head, 8 pounds compared to 5.47 pounds, and partly owing to the more efficient use of the grain fed.

SPECIAL ADVANTAGES.

By means of the self-feeder the average farmer will have as good results as the most expert hand-feeder, and the results will be obtained at much less expense of time and labor. For the average farmer there is little doubt which method is the more economical, for, as is shown in Table 3, the self-feeding system is advantageous in every respect. Its use results, first, in larger daily gains in live weight, bringing the pigs to a marketable size at an earlier date; second, feed is consumed more rapidly, as shown by the average of the "daily feed per head" in Table 3; and, third, as there is an actual saving in the amount of feed required to produce 100 pounds of gain, it is shown that the increased feed consumption and the more rapid daily gains are not made at the expense of efficient use of the feed. On the contrary, a smaller amount of feed is consumed in making pork,

FIG. 1.—Forage supplemented with grain and tankage in the self-feeder is an excellent combination for fattening hogs.

which is a fact of extreme importance at present. The last and one of the most important advantages to the farmer at this time is the saving of labor, for although daily watch must be kept on the self-feeder to see that each compartment is well supplied and not clogged, this requires only a fraction of the time necessary to hand-feed the same hogs several times a day.

HINTS ON THE USE OF THE SELF-FEEDER.

The self-feeder (fig. 1) may be adapted to the use of any kind of grain or feed, although shelled grain and ground feeds are most commonly used. It may be adapted to handle ear corn, but such a feeder must be of large size and heavily made in order to hold sufficient grain to feed a bunch of hogs several days without refilling.

FIG. 2.—Hogs eating milo maize from a self-feeder.

In order that the self-feeder may readily be adapted to different kinds of grains it should be constructed with some means of regulating the opening through which the feed passes. For example, corn meal or barley requires a smaller opening to prevent too rapid a flow of grain than is required in the case of shelled corn. A well-constructed self-feeder will last a number of years, and as it may not always be convenient to feed the same grain every season some provision must be made to accommodate different sizes of grains.

Care should be taken to see that the self-feeder is always supplied with each feed, for if one part of the ration is missing the pigs will naturally eat an increased amount of any other available nutrient, and in such a case will make very poor use of it. For example, when tankage and shelled corn constitute the ration, if corn were to become exhausted the shoats would naturally eat a very large amount of tankage, which would not only fail to produce rapid gains, but would increase the consumption of a very high-priced feed. Too much emphasis can not be placed upon this point, for the beginner is apt to become careless in the use of a device which does not require constant care.

Two methods are in vogue in the preparation of grains for the self-feeder. The grain and the protein supplement to balance the ration may be mixed and fed from one self-feeder, or, better, the two

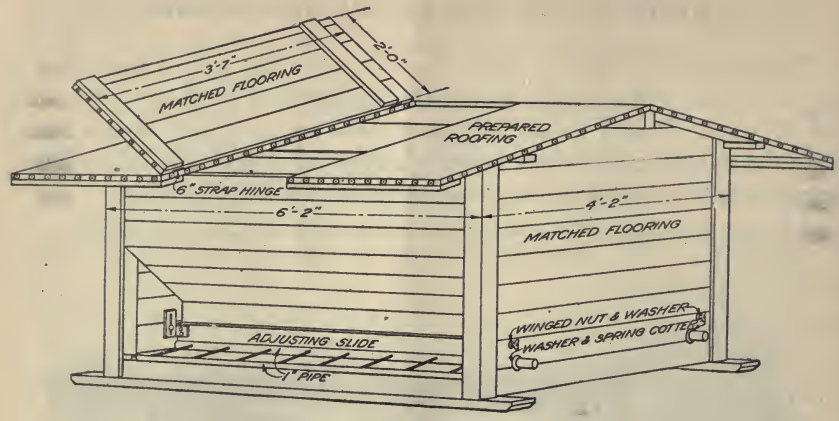

FIG. 3.—The Iowa self-feeder.

or three feeds to be used may be fed separately, either in different self-feeders or in different compartments of the same feeder. Where the feeds are not mixed the pigs may balance their rations as their appetites demand, in which case it has been found that they eat relatively less of the high-protein feeds as they gain in weight. This effects a material saving in the high-priced feeds consumed.

Permitting the hog to feed himself does not have the drawbacks to which such a system would be liable in the feeding of other kinds of animals, for he does not gorge himself until he becomes sick or loses his appetite. With the self-feeder the hog makes the most economical use of grain in the production of pork and gains weight most rapidly; he fattens more quickly, gets to market at an earlier date, and saves labor in his feeding and care. The quickest, the

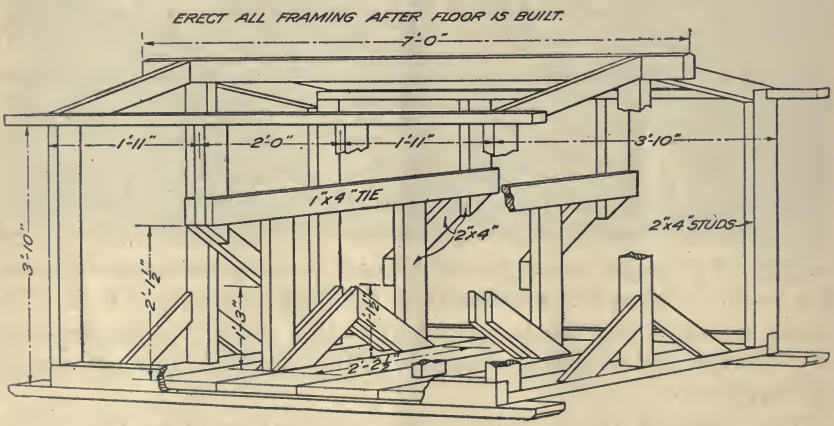

FIG. 4.—Framing detail of Iowa self-feeder. (Erect all framing after floor is built.)

easiest, and the most economical method of fattening pigs, with the least expenditure of grain and labor, is through the use of the self-feeder.

REQUIREMENTS OF A SELF-FEEDER.

The self-feeder should be designed primarily to keep an available supply of grain constantly before the hogs, and at the same time protect the contents against waste due to wind and rain. (Figure 2.)

A self-feeder consists of a hopper to hold the feed and a trough below it into which the grain flows as the pigs eat it. The hopper is made of such size that it will contain several days' supply of feed,

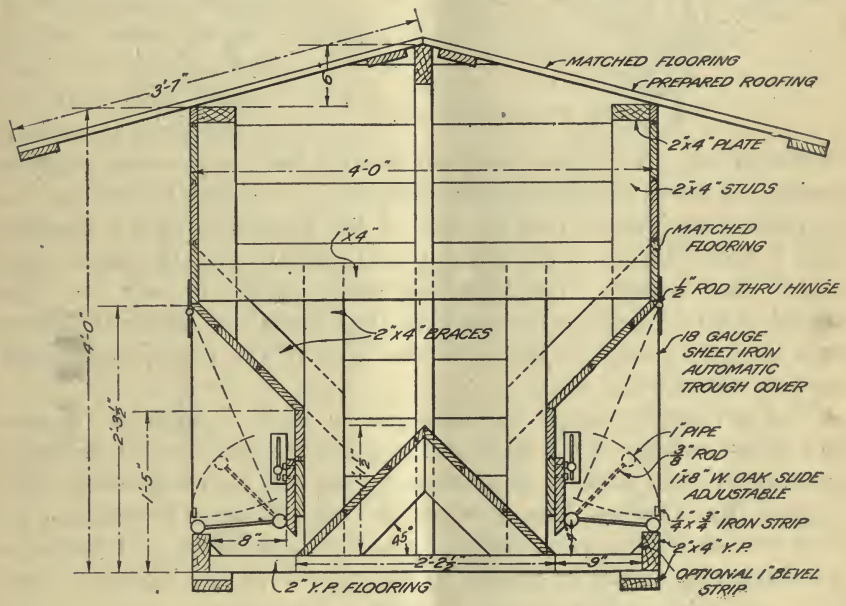

FIG. 5.—The Iowa self-feeder; cross section through center.

and the inside walls are made as smooth as possible in order not to obstruct the flow of grain to the trough. At the bottom of the hopper, leading into the feed trough, an adjustable slide should be placed to control the rapidity of the grain flow. This slide usually takes the form of a board running lengthwise of the feeder and fastened to the hopper by wing bolts. A certain amount of flexibility in this slide will aid materially in preventing clogging, for the constant rooting of the pigs against such a board will cause the contents to flow down more freely.

Best results are obtained when the self-feeder can be placed under cover, but as this is nearly always impossible the feeder must be con-

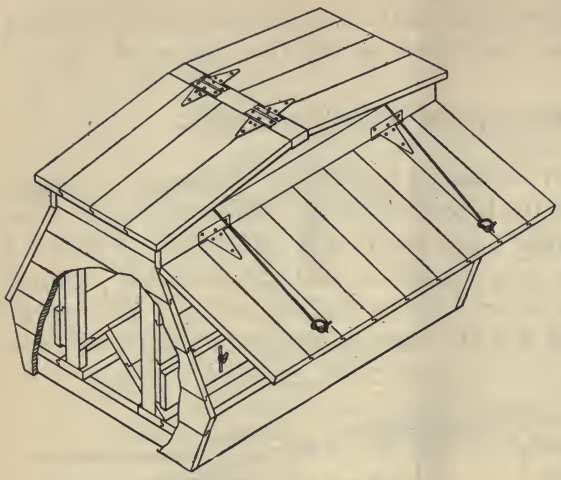

FIG. 6.—The Ohio self-feeder.

structed to protect the contents from the weather. This is best accomplished by covering the end of the trough to keep out the wind and by projecting the roof to drain off the rain. Many variations are possible. The Ohio self-feeder is made with a hinged cover which fits over the feed trough and may be closed when the feeder is not in use. The plan designed by the Iowa experiment station presents a novel solution of this difficulty. A piece of sheet iron is suspended by hinges from the side of the hopper in such a manner that it hangs inside of the opening and directly over the outer edge of the feed trough. The hogs can easily push this back over the trough while eating, but as soon as they leave the feeder the sheet iron is heavy enough to swing to the front of the trough again and exclude all rain and wind.

The self-feeder should be built upon a pair of skids or runners to prevent rotting of the floor and to facilitate moving. If strongly constructed this method of transportation will be much easier and quicker than loading upon a wagon or sled. When it is desirable to feed two or more concentrates separately in the same self-feeder a partition may easily be placed in the hopper at any distance from one end. By using the best grade of lumber and applying yearly a coat of paint a well-constructed self-feeder will give service through a number of years.

PLANS OF SELF-FEEDERS.

The two types of self-feeders represented in the plans

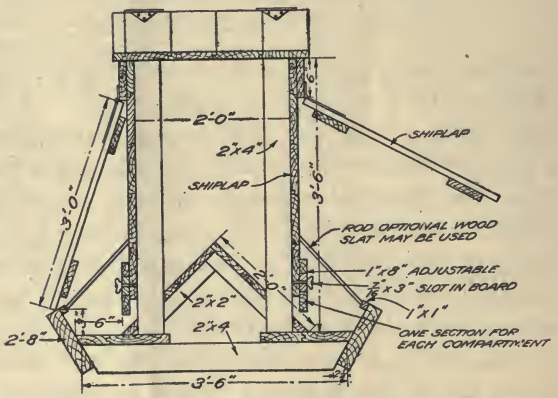

FIG. 7.—The Ohio self-feeder; end view with end siding boards removed.

shown are are both excellent and practical. The first was designed by the agricultural engineering section of the Iowa experiment station and the second by the agricultural extension service of the Ohio State University, through whose courtesy they are reproduced.

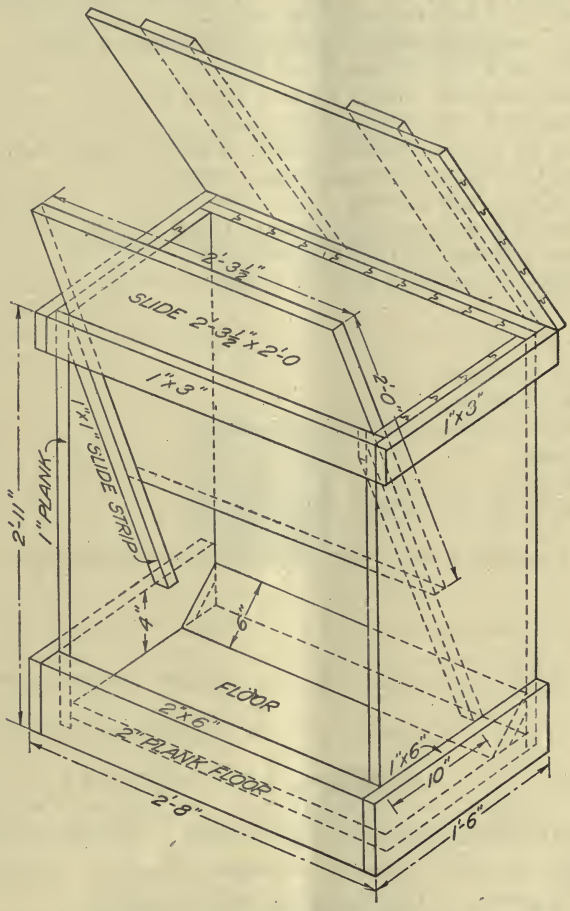

FIG. 8.—Self-feeder used at Government Experiment Farm, Beltsville, Md.

The Iowa self-feeder (figs. 3, 4, and 5) will accommodate 40 large shoats and has a capacity of 50 bushels of shelled corn. Its construction will require approximately the following amount of lumber, besides the hardware:

Lumber required for the Iowa self-feeder.

	Board feet.
1 inch matched siding	210
1 inch by 4 inch boards	12
2½ inch flooring	60
2 inch by 4 inch framing material	80
Total lumber	362

The Ohio self-feeder, a very practical and economical type, is shown in figures 6 and 7.

Bill of materials necessary for the Ohio double self-feeder.

	Board feet.
24 pieces ⅞ inch by 8 inch shiplap, 6 feet long	96
20 pieces ⅞ inch by 8 inch shiplap, 2 feet 10 inches long	38
10 pieces ⅞ inch by 8 inch shiplap, 3 feet long	20
10 pieces ⅞ inch by 8 inch shiplap, 4 feet 6 inches long	30
12 pieces ⅞ inch by 8 inch shiplap, 2 feet long	16
8 pieces 2 inch by 4 inch framing material, 3 feet 6 inches long	19
2 pieces 2 inch by 4 inch framing material, 4 feet long	6
2 pieces 2 inch by 2 inch framing material, 4 feet long	3
6 pieces 2 inch by 2 inch framing material, 1 foot 6 inches long	6
2 pieces 2 inch by 8 inch for trough, 6 feet long	16
4 pieces 1½ inch or 2 inch by 8 inch for trough, 6 feet long	32
Total	286

4 pieces 8 inch T hinges.
4 pieces 6 inch T hinges.
12 pieces ⅜ inch by 2½-inch bolt, with thumbscrew.
6 pounds 8d nails.
3 pounds 20d nails.
20 square feet prepared roofing.

Capacity of the various sized feeders of the Ohio type.

	Hogs accommodated.
6 feet long, 15 bushels shelled corn, 400 pounds middlings, 315 pounds tankage	50
8 feet long, 20 bushels shelled corn, 540 pounds middlings, 420 pounds tankage	75
10 feet long, 25 bushels shelled corn, 670 pounds middlings, 525 pounds tankage	100

The self-feeder shown in figure 8 is one used at the Government Experiment Farm at Beltsville, Md. This self-feeder is very handy for suckling pigs while they are with their mother. A picture of this self-feeder is given on the title page of this bulletin.

A self-feeder of this type can be placed in the corner of the lot in which the sow and pigs are kept. Place a few boards across the corner from one fence to another to keep out the sow. Allow space enough under the bottom board to permit the young pigs to crawl under. They form a creep for the young pigs, which can learn to eat very readily without being disturbed. Cracked corn, or corn meal and tankage mixed in the proportion of 10 to 1, is an excellent ration. As the pigs grow older whole corn can be substituted for cracked corn or corn meal.

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BEAN GROWING IN EASTERN WASHINGTON AND OREGON AND NORTHERN IDAHO

LEE W. FLUHARTY
Assistant Agriculturist

Revised by BYRON HUNTER, Agriculturist

FARMERS' BULLETIN 907
UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF THE SECRETARY
Contribution from the Office of Farm Management
W. J. SPILLMAN, Chief

Washington, D. C. Issued December 8, 1913, as No. 561; revised, November, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

BEAN GROWING can be successfully conducted in eastern Washington and Oregon and northern Idaho, without seriously interfering with the major industry of that section—wheat growing.

In fact, in that section, there are thousands of acres lying idle as summer fallow which are well adapted to bean growing and at slight additional expense with practically the same equipment can be made to produce 800 pounds of beans per acre, which at present prices affords no small addition to the farmers' receipts.

This bulletin describes the methods followed by the most successful bean growers, showing that, where moisture for crop production is present and no frosts occur between May 10 and September 15, beans have been incorporated in the cropping system with profit.

BEAN GROWING IN EASTERN WASHINGTON AND OREGON, AND NORTHERN IDAHO.

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AREA SUITED TO CROP.

THE ARABLE LAND of eastern Washington, eastern Oregon, and northern Idaho has been devoted almost exclusively to the production of wheat, oats, and barley for more than 30 years. Because of the introduction of serious weed pests soon after the land was brought into cultivation it was found unprofitable to grow a crop of grain each year. Many of the new settlers had come from the Willamette Valley, Oreg., where wheat and oats were grown by summer-fallowing the land every second or third year. Hence, they naturally turned to that system of farming as a solution of their weed problem, and the growing of small grain by the summer-fallow method is still the general practice among the farmers of this region. Under this system of farming from one-third to one-half of the land lies idle each season.

Wheat, oats, and barley are the crops most universally grown there, yet a portion of the region is well adapted to the production of beans. The area best suited to this crop lies along the foothills of the Blue Mountains in Umatilla County, Oreg., Walla Walla, Columbia, Garfield, and Asotin Counties, Wash., and along the foothills of the Craig Mountains and adjacent to the canyons of the Clearwater and Potlatch Rivers in Nez Perce, Lewis, and Latah Counties, Idaho. There are a few districts in Whitman, Spokane, and Stevens Counties, Wash., also, where the climatic conditions are favorable for bean culture. While it is true that only a limited area is especially adapted to this crop, a careful study of all the details of its production shows that there are thousands of acres now lying idle each year as summer

fallow which might be used for growing beans as an intertilled crop. This crop has been grown in parts of Nez Perce and Latah Counties, Idaho, for the past 20 years, and the bean hullers make their regular fall runs the same as the grain thrashers. The crop has also been grown in a more limited way near Weston, Oreg., for about 20 years. The production of field beans in this territory is therefore past the experimental stage. A few days spent in the vicinity of Kendrick, Idaho, visiting bean growers during the months of July and August will convince the skeptical of this fact.

FACTORS FAVORING BEAN PRODUCTION.

Two factors largely determine where beans may be grown successfully: (1) The annual precipitation must be sufficient to produce a crop each year and (2) the growing season from May 10 to September 15 must be approximately free from frosts. Owing to their proximity to the mountains the districts previously mentioned receive sufficient precipitation for growing beans where proper cultural methods are employed.

The deep ravines leading down from the mountains in these regions give protection from frosts during the growing season by furnishing excellent air drainage. While the danger from frosts increases with the elevation, air drainage is the principal regulating factor. In parts of Nez Perce County, Idaho, where the deep canyons furnish good air drainage, beans are being grown successfully at an elevation of 3,000 feet. In other parts of the same county having a lower elevation but poor air drainage, this crop can not be grown on account of the late spring and early autumn frosts.

Three factors which are within the control of the farmer affect success of the bean crop, namely, the quantity of moisture stored in the soil at the time of planting, the methods employed in growing and harvesting the crop, and the presence of the nodule-forming bacteria in the soil. It is the purpose of this bulletin (1) to encourage bean culture in those localities that have a frost-free season of sufficient length to insure maturity and have enough rainfall to grow beans on land that usually lies idle as summer fallow, (2) to discuss in detail the cultural methods which have been worked out during the past 20 years by the most successful farmers in the bean-growing districts, and (3) to give directions for supplying the soil with nodule-forming bacteria.

METHODS USED IN BEAN PRODUCTION.

The success of the bean crop depends largely upon the thorough preparation of the seed bed. The work of preparation should begin in the early autumn. The most successful growers work the grain

stubble into the soil with a sharp disk harrow soon after the coming of the first fall rains. After such treatment plowing evenly distributes the stubble throughout the soil, where it quickly decays and prevents packing. It may not always be possible to disk the stubble in the fall because of the rush of work at that season. If, however, the plowing is to be delayed until the following spring, fall disking is even more necessary.

FALL PLOWING.

Land that is to produce a crop of beans should be plowed to a depth of 6 or 8 inches in the fall soon after the soil becomes damp enough to be worked, or at the latest in the early winter. It is then allowed to lie until early spring in the rough state as left by the plow. Thus the winter's precipitation is absorbed by the soil instead of being lost by running off, as is frequently the case with much of the rainfall when the land lies as a stubble field during the winter. When dry enough in the spring the soil is stirred once or twice with a disk or other suitable implement and then harrowed. A dry earth mulch is maintained until planting time for the purpose of retaining soil moisture and destroying weeds. This generally requires from three to four cultivations at intervals of 8 or 10 days. The use of the packer is not usually necessary after fall plowing, as the winter rains and numerous spring cultivations firm the soil sufficiently.

SPRING PLOWING.

Although plowing in the fall or early winter is preferable, it is sometimes done in the spring as soon as the ground is in condition to be worked. When the plowing is postponed the land should have been disked the previous fall. Fall disking works the stubble into the soil and puts the ground in condition to catch and retain the winter's moisture. Cultivation is begun immediately after plowing for the purpose of checking evaporation and the germination of weed seed. The harrow must follow not more than one-half day behind the plow. Some farmers attach a section of a harrow to the gang plow and perform the two operations at the same time. A subsurface packer is sometimes used for the purpose of firming the soil and reestablishing capillarity. If used, the packer is run immediately behind the plow, and it in turn is followed closely by a drag harrow. The land is then handled until seeding time in the same manner as the fall-plowed ground. Plowing must never be delayed until late spring, for that permits the soil to become so dry that it breaks up in hard clods and much extra labor is necessary in preparing a suitable seed bed.

PLANTING THE BEAN CROP.

Time to plant.—The time of planting varies from May 10 to June 5, according as the season is early or late. When planted too early, cold weather, together with an excessive quantity of moisture in the soil, often causes the seed to decay before germination begins. Even if a good stand is secured under such unfavorable conditions the crop usually develops and ripens very unevenly.

Method of planting.—If the land to be planted is comparatively level and free from weeds and there is sufficient rainfall, the largest yields are secured by planting the beans in rows 28 inches apart and

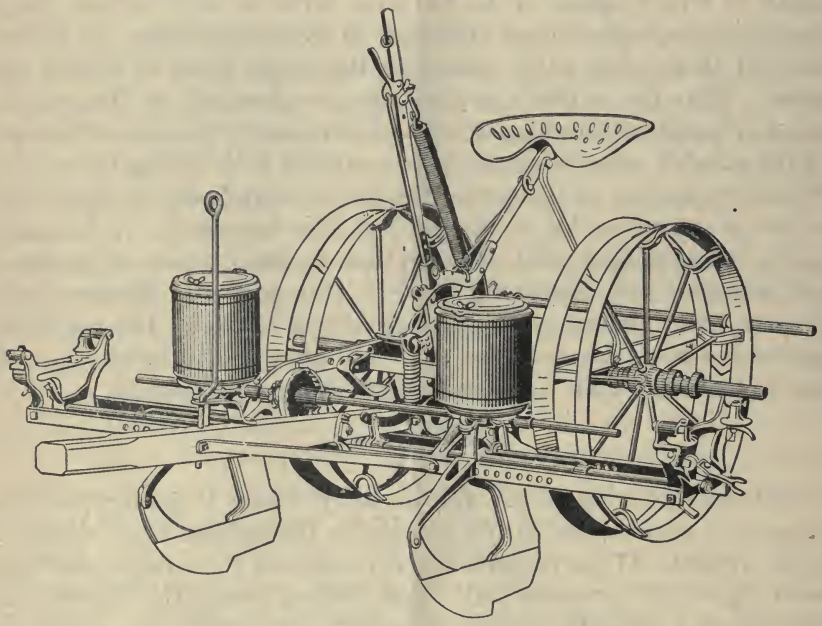

FIG. 1.—A double-row bean or corn planter.

dropping a bean every 2 to 3 inches in the row. If planted this way the beans will ripen a little earlier and more evenly and the quality will be more uniform. If the ground is so foul as to require extensive cultivation, the beans should be planted in checks with the hills 30 inches apart each way. About 7 beans should be planted in each hill. If planted in this way the beans can be cultivated each way. Land that will require only a medium amount of hoeing may be planted in rows 30 inches apart with hills about 15 inches apart in the rows. An average of 7 beans should be planted in each hill. On very steep land the rows should run straight up the hill. If the surface of the field to be planted slopes in more than one direction, it is frequently advisable to change the direction of the rows so that

they will run straight up the hill on the steepest parts of the fields. This makes it much easier to cultivate and harvest the beans.

The double-row bean and corn planter is used almost exclusively for planting the crop. An excellent type of planter is shown in figure 1. This planter may be adjusted to plant in rows from 28 to 44 inches apart. By using a special 30-inch wire it will also plant the hills in 30-inch cross checks. The feed plates may be made to drop the desired number of seeds in each hill by regulating their speed. The planter is also equipped with an automatic hill-drop attachment which drops the hills from 17 to 52 inches apart in the row.

A hand corn planter is often used for planting where only a small acreage is to be grown. The ground is marked off in checks about 30 inches square and the beans dropped at the intersection of the marks. An experienced man can plant from 4 to 7 acres a day by this method. If the ground is free from weeds, so that but little cultivation is necessary, the seed is often planted in drill rows with either a bean planter or an ordinary grain drill. Of the two, a bean planter which has a drill attachment is the more desirable.

A grain drill having feed cups which will handle beans may be used with fair success. An 11-row grain drill with spaces of 7 inches between the grain tubes can be adjusted for drilling beans in rows 28 inches apart by stopping up all of the feed cups except the second, sixth, and tenth. The machine is so regulated as to plant the seed from 3 to 6 inches apart in the row.

The depth at which the beans are planted depends upon the character of the soil and the weather conditions. They are not planted so deep in dark, heavy soil as in a lighter soil. Neither can beans be planted to a very great depth during cold, damp weather without injuring the stand. The safe plan is to plant just deep enough for the seed to lie in moist earth, for an even stand of strong, healthy plants is one of the first requirements of a good bean crop.

INOCULATION.

For the successful culture of beans there must be nodule-forming bacteria in the soil. If these bacteria are present they form on the roots of the bean plants little lumps called nodules. By the aid of the bacteria living in the nodules the bean plants are able to assimilate atmospheric nitrogen. Without the help of these bacteria they must obtain their nitrogen from the soil. If the nodule-forming bacteria are not present in the soil they may be supplied in one of two ways: (1) Pure-culture inoculation and (2) soil inoculation.

Pure-culture inoculation material is furnished to farmers by the Oregon Agricultural College, the Washington State College, and the

University of Idaho. The United States Department of Agriculture also furnishes it in small quantities for demonstrational purposes. Directions always accompany the pure-culture inoculating material.

Beans may be inoculated by using soil in either of two ways: (1) The beans to be treated are placed upon a tight floor, sprinkled with water, and shoveled over until each bean is wet. Only just enough water should be used to wet the beans. The wet beans are then sprinkled with pulverized soil taken from a field or garden which had in the previous year produced beans with nodules on their roots. About one pint of soil is sufficient for a bushel of beans. After applying the soil the beans are again shoveled over until some of the dirt has stuck to each bean. (2) By the second method the inoculating soil is placed in a bucket of water and stirred until the soil lumps have disappeared. The seed is then sprinkled with the dirty water and thoroughly stirred with a shovel to insure the wetting of each seed. From 1 to 1½ pints of water should be sufficient for a bushel of seed.

In using either of these methods care should be taken to use only sufficient soil to place a very little on each seed. If too much soil is used it is difficult to get the seed through the drill. Since only a small amount of soil is used, it should be gathered very carefully. Only soil should be used which has been in direct contact with bean plants having plenty of nodules on their roots. It should have been gathered during the previous summer and stored in a cellar or damp shady place until it is used. It should also be understood that inoculation will do little or no good except on land which never produced beans before or on land where beans have partially failed because of the absence of the nodule-bearing bacteria. On land which has recently produced beans successfully it is not necessary to inoculate the seed.

QUANTITY OF SEED PER ACRE.

The quantity of seed required per acre depends upon the size of the beans and also upon the manner of seeding. The pea-bean varieties, such as the Little Navy, the Lady Washington, and the Red Miner, require from 24 to 30 pounds per acre when planted in checks 28 inches square. If planted in drills or checked 30 to 36 inches apart only 20 to 25 pounds of seed will be necessary. The larger seeded varieties require more seed per acre than the smaller varieties.

It is considered very essential that the number of plants grown on a certain area be sufficient to maintain a proper balance between the soil moisture and the moisture requirements of the plants. If this balance is properly maintained the beans ripen evenly and a uniform crop is produced. In the sections where beans are being grown at

present, from 6 to 8 seeds in each hill produce the proper number of plants. If a smaller number of seeds is planted in each hill there is often moisture enough in the ground to keep the vines growing late in the fall, and the late beans are sometimes damaged by early fall frosts. This problem must be worked out, however, for each locality having different soil and moisture conditions.

CULTIVATION OF THE BEAN CROP.

A thorough preparation of the seed bed, as indicated above, leaves the soil in excellent tilth, destroys most of the weeds, and hence materially lessens the cultivations necessary after the beans are planted. The number of cultivations depends upon so many factors that no fixed rule can be made to apply to every case. For this reason the statements which follow must be taken in a general sense.

If the ground is very foul the shovel cultivator is run immediately behind the planter. In two or three days, or just before the plants begin coming through the ground, the field is cultivated with a light drag harrow. The harrow destroys the small weeds, levels the surface of the ground, and puts the soil in splendid condition to be cultivated as soon as the plants are large enough. If weed seed germinate at the same time as the beans, the ground is harrowed again after the plants are up.

Some growers fear to use the harrow, lest they injure the stand by breaking off the young plants. Very little damage is done, however, if the seed bed has been so well prepared that the ground is level and free from clods and if a light harrow is used. Several growers near Weston, Oreg., have followed this practice for a number of years with satisfactory results.

One harrowing, either before or after the plants are up, is sufficient if the ground is comparatively free from weeds. It should be done when the weeds are most easily destroyed. Two or three additional cultivations during the growing season are usually necessary. The soil is not stirred to a depth of more than 2 or 3 inches, for the reason that the bean is a surface feeder and deep cultivation is liable to disturb the rootlets and thus weaken the plant by diminishing the food supply.

The implements employed in cultivating corn are the ones usually used in bean culture. Sweeps are substituted for the shovels, as they are better adapted to shallow cultivation. Level cultivation is practiced at all times. Cultivation is discontinued when the vines begin blooming, for the flowers are easily knocked off, and late stirring of the soil keeps the plants growing, making them liable to injury by early fall frosts.

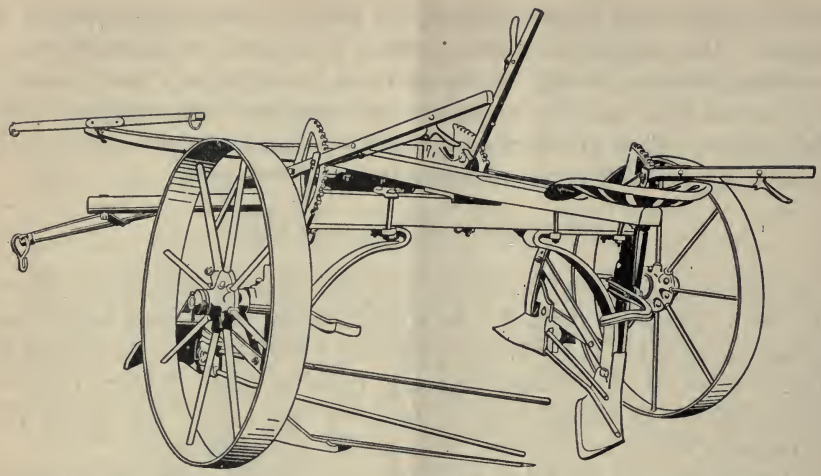

FIG. 2.—The double-row bean cutter generally used for harvesting the crop.

HARVESTING THE BEAN CROP.

In the bean-growing districts of Nez Perce and Latah Counties, Idaho, the bean harvest usually begins about September 10. The date varies, however, from August 25 to September 20, according to the season, the altitude, and the varieties grown.

A double-row bean cutter similar to the one shown in figure 2 is generally used for cutting the crop. One man with two good horses can cut from 12 to 14 acres per day with a machine of this kind. The double-row sled bean cutter shown in figure 3 is also a very satisfactory implement, especially on steep land, as the runners tend to prevent slipping down the hill. This implement requires three horses.

When the pods have turned yellow and before they have dried out the vines are cut just below the surface of the ground. Either of the cutters here described cuts two rows at a time and forces the vines into one windrow. Two men with pitchforks follow immediately behind the cutter and place three of the windrows into one row of piles.

The plants are left piled in the field until the vines are thoroughly dry. It seldom takes more than two or three days for them to become dry enough to be hauled to the bean huller or stacked in the field or in sheds. Stacking in the field before thrashing is growing in favor, since in this way a larger acreage may be handled without danger of damage from rain. It is during the time the beans are lying in piles between cutting and thrashing that there is danger of damage from rain. If stacked, such damage is not liable to occur, as the stacking can begin within a couple of days after cutting and the beans are left in piles only a short time. Another advantage

of stacking is that the vines go into a sweat soon after they are stacked and do not become thoroughly dry for three or four weeks after the sweating process begins. While in the sweat the vines, pods, and seed become toughened, and there is less danger of cracking than if thrashed directly from the field.

The side-delivery hayrake is now coming into use in harvesting beans in Latah and Nez Perce Counties, Idaho. When this implement is used the beans are allowed to dry partially in the windrow as left by the bean cutters. Two of these windrows are then thrown together by driving the rake over the field. Another windrow is then combined with the two by driving the rake on the next windrow but in the opposite direction, thus making a windrow composed of six bean rows. If the weather is favorable, the beans are hauled direct from these large windrows to the thrasher, stack, or bean shed. If the weather is unfavorable, the beans are piled into bunches in a manner similar to that described above.

Stacking.—The stacks are built on a layer of straw 12 or 14 inches thick in order to keep the pods from coming into contact with the ground. The straw also catches the seeds which are trampled out during the stacking process. The beans are separated from the straw by running both through the huller. The stacks are kept dry by covering them with heavy canvas. An excellent way to protect the beans until thrashed is to cover them with straw. On the top of the stack the covering should be 12 to 15 inches deep. The straw is held in place by a network of wires or binder twine. Making the cover waterproof is important, for a leak may discolor the beans from the top to the bottom of the stack.

When handled properly beans are no more liable to damage from rain than grain crops. If a rain should come before the beans can be stacked they are turned as soon as the ground dries. The pods

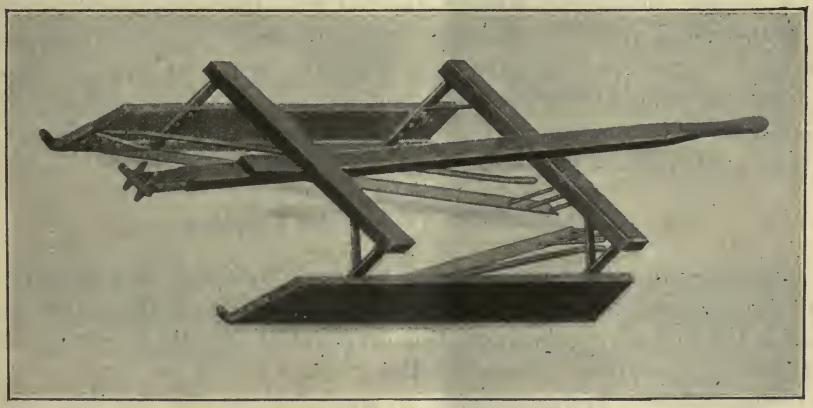

FIG. 3.—A double-row sled bean cutter.

must lie but a short time on the wet earth, as the seeds absorb moisture readily and are liable to become discolored. Care must also be exercised in handling the vines after they become thoroughly dry, for the pods crack open easily and much loss may result from shattering.

A bean crop may sometimes ripen so late in the season and rains may come so frequently that it is impossible to get the vines dry enough to stack in the usual manner. Crops caught in this condition have been saved by stacking in the driest possible condition in narrow stacks about 10 feet wide. During the construction of the stack, poles, rails, or fence posts are placed in it to give the beans ventilation. They are placed lengthwise of the stack and are separated by layers of beans from 18 to 24 inches thick. As the stacks must stand until the following spring or summer before the beans can be thrashed, they must be well covered.

THRASHING THE CROP.

The thrashing is usually done with a bean huller, a machine designed to minimize the loss from cracking. Good work may be done with a grain separator, provided the vines have remained in the stack long enough to be in the sweat and the speed of the cylinder is slowed down to 300 or 400 revolutions per minute, the speed depending on the diameter of the cylinder. All but one row of the concave teeth and half of the cylinder teeth are removed, the separating parts of the machine are run at the same rate as when thrashing grain, and none of the thrashed beans are allowed to pass from the elevator into the cylinder a second time.

In districts where beans are a staple crop the bean hullers make a regular fall run, the same as grain thrashers. The charge for thrashing is usually 30 cents per sack, full sacks weighing from 140 to 150 pounds. This makes the charge about 20 cents per hundredweight. The charge includes all labor connected with thrashing except hauling the vines from the field to the machine in case they are not stacked. Growers who have only a small acreage or who live in a community where there are no hullers do their thrashing with a grain separator or by means of a flail. Two men can flail out and clean up about 1,800 pounds per day.

MARKETING THE BEAN CROP.

Cleaning and grading in order to get a uniform and attractive product are very important items in the marketing of dry beans. As far as the farmer is concerned, this preparation usually ends with the thrashing operation. Many of the grain warehouses in the bean-growing districts are equipped with special machinery for this work. The farmer delivers his beans to the warehouse just as they come

from the bean thrasher. He receives a load check, and his beans are kept in a separate pile. He then has the choice of selling them in this condition, or he can have them recleaned, scoured, separated into two grades (large and small), and placed in sacks weighing 85 pounds each. After this work is done, the farmer receives a negotiable warehouse receipt in exchange for his load receipts. The minimum charge for recleaning, scouring, and grading is $2 per ton.

Before the war affected prices the growers usually received from $3 to $4.50 per hundredweight, the price varying according to the size and quality of the product. The smaller beans are most in demand and sold at a price from 50 to 75 cents per hundredweight higher than the larger beans.

It is sometimes necessary to hand-pick the crop on account of discolored beans if the harvest season is damp. The weather conditions are usually such, however, that hand picking is not necessary if the crop is handled properly. The operation of hand picking is greatly facilitated by a small machine, operated by foot or other motive power, and consisting of a canvas belt 7 or 8 inches wide passing over rollers driven at a low speed. The beans are fed to the belt from a hopper and as they are carried along the pickers remove the discolored seed and foreign particles. The sound beans pass to the end of the canvas and drop into a sack or other receptacle.

VARIETIES OF BEANS GROWN.

The three varieties of beans most extensively grown in the regions mentioned are the Lady Washington, the Little Navy, and a variety locally known as the Red Mexican, or Red Miner. Many strains of the Little Navy have different minor characteristics. They are grown under such names as Banner Leafless, Prolific Tree, and Prize Winner. The Red Mexican, or Red Miner, is the earliest of the three varieties and is preferred for late plantings or high altitudes where the season is short. All three of the most popular varieties are somewhat spreading and branching in character; they are very vigorous growers and extremely hardy. The Little Navy is especially prized for its hardiness, productiveness, evenness in maturing, and its uniformly well-filled pods.

IMPROVEMENT OF THE SEED BY SELECTION.

By carefully studying a field of maturing beans one will observe a wide variation in the individual plants. It will be seen that some of the plants are mature, while others are still green; that some are heavily laden with well-filled pods, while others bear only a small number of seeds. On account of this variation it is possible to

greatly improve the crop by careful seed selection. The object of such selection is to increase the yield and vitality of the seed, to improve its quality, and to produce plants that will ripen evenly. In certain localities it is also desirable to select early-maturing plants in order to shorten the time required for maturing the seed. It is impossible, however, to obtain permanent results unless such selection is practiced every year, for bean plants have a strong tendency, if selection ceases, to return to the original type.

A practical method of seed improvement used by the most successful plant growers is as follows: In starting the work a large number of plants heavily laden with ripe pods are selected from the field at the time of maturity. The plants are taken from parts of the field where the stand is uniform and from soil which is representative of the general soil conditions. Plants from the outside rows or where the stand is poor are not representative and must not be used in seed selection.

The plants are pulled by hand, removed from the field, and carefully inspected to secure the 25, 50, or 100 which are best. These are thrashed individually and the beans from each plant put in separate paper bags, which should be numbered.

The following year these selected seeds are planted by hand, a separate row to each paper bag. Toward harvest time this will be the most interesting plat on the farm, since the grower will soon see that when selecting his best plants the preceding fall in many cases he did not "know beans." Quite a number of rows in this plat will be found to have produced progeny which are distinctly inferior in some respect. Here the advantage of these "progeny rows" will be apparent, since the grower is able to discard the bad rows entirely, whereas if he had not planted the seed from each selected plant to itself it would be practically impossible to remove the poorer types by roguing. One or a few rows will be found to be markedly better than the rest, and all of these good rows should be saved for next year's seed plat. The remainder of the seed plat, after discarding a few rows which may be distinctly bad, can be used to plant the field.

By one year's individual selection a strain can be established which may be kept fairly pure by discarding all the inferior plants from the seed plat. The plat should be sown each year and should be large enough to furnish all the planting seed desired. The extra labor in thrashing which this selection plan requires will come at a time of year when it can be spared, since the selected plants may be stored unthrashed for a while. The labor of hand planting will be richly repaid by the greater producing value of a selected strain of beans.

BY-PRODUCTS OF THE BEAN-GROWING INDUSTRY.

The value of bean straw as a rough feed is not fully appreciated by most growers. While a few farmers are feeding their bean straw, most of it is burned immediately after thrashing. Others allow it to partly decay in large piles and then use it as filling for ditches or as a fertilizer. When not allowed to become damp or moldy, bean straw makes a splendid roughage for either sheep or cattle, and when fed in conjunction with grain it is a very good substitute for hay.

Bean straw is superior in feeding value to wheat hay and but little inferior to barley hay. Beans ordinarily will yield from one-half to three-fourths of a ton of straw per acre. Taking as a basis the price paid before the war for wheat hay in the bean-growing section, bean straw should be worth from $5 to $8 per ton when fed on the farm and the manure returned to the soil.

While there is but little waste caused from decay or discoloration of the seed during harvest, sometimes there is a quantity of cull beans due to the splitting or cracking of the seed during thrashing. These culls make very good hog feed when thoroughly cooked and fed in conjunction with other grain.

CONCLUSIONS.

Thousands of acres of land are lying idle as summer fallow each year in eastern Washington, eastern Oregon, and northern Idaho that are well adapted to the growing of beans. Twenty years' experience shows that about as good cereal crops can be grown following beans as after an ordinary summer fallow. The cultivation of the bean crop replaces the work necessary to care for the fallow, and leaves the soil in excellent condition for seeding winter wheat. The crop is also harvested in ample time to permit fall seeding.

Beans do not seriously compete with wheat for labor, and the two crops can be grown with practically the same equipment. Approximately $150 worth of extra machinery is needed to plant, harvest, and cultivate from 70 to 80 acres of beans instead of cultivating the land as summer fallow. With the wage for man and horse labor which prevailed before the European war it required about $6 more per acre to grow, harvest, and market a crop of beans than it did to summer-fallow an equal area. Since beans yield on the average about 800 pounds per acre, the gross return per acre would be approximately $24 if sold at 3 cents per pound. At this price in districts adapted to bean culture, beans were approximately $18 per acre more profitable than summer fallow, and at present prices a greater profit would be shown.

Generally speaking, the soils of the bean-growing districts are rich in all of the mineral elements necessary for plant growth. Under

such conditions the maintenance of soil fertility will depend almost entirely on keeping up the organic matter of the soil. This is not easily accomplished when beans and cereal crops are grown exclusively. Stubble always should be plowed under instead of being burned. The plowing under of partially decayed bean and wheat straw will also do much toward keeping the soil in a productive condition. The decayed straw should be scattered rather thinly over the grain stubble in the fall. It should be thoroughly worked into the surface soil with a sharp disk harrow and plowed under as soon as possible after the first autumn rains. The disking causes the straw to mix thoroughly with the soil at the time of plowing instead of forming a layer in the bottom of the furrow.

The permanency of the agriculture of the present bean-growing districts would be increased materially by the adoption of the following three-year rotation:

First year, wheat, oats, or barley, with clover sown with the cereal crop.

Second year, clover used for pasture, hay, or a seed crop.

Third year, beans.

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INFORMATION FOR FRUIT GROWERS ABOUT INSECTICIDES, SPRAYING APPARATUS, AND IMPORTANT INSECT PESTS

A. L. QUAINTANCE
Entomologist in Charge of Deciduous Fruit Insect Investigations, and

E. H. SIEGLER
Entomological Assistant

FARMERS' BULLETIN 908
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. February, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

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INFORMATION FOR FRUIT GROWERS ABOUT INSECTICIDES, SPRAYING APPARATUS, AND IMPORTANT INSECT PESTS.

SPRAYING TO CONTROL FRUIT INSECTS.

INSECT CONTROL IN ORCHARDS AND VINEYARDS is largely effected by spraying, and the needs of the fruit grower in the protection of his crops from the attack of insects and fungi have been the predominating factors in the development of our present excellent lists of insecticides and our variety of spraying apparatus.

Although spraying is one of the more expensive of the several orchard operations, the value of the crop is so greatly increased thereby that it is a comparatively small investment, the expense amounting to only a fraction of the returns directly due to the practice. Orchard spraying is, in fact, an exceedingly cheap form of insurance.

It must not be inferred, however, that spraying operations are uniformly successful. While a considerable degree of skill in spraying has now been reached by a large proportion of fruit growers, there is still room for much improvement. Of all orchard work, spraying is most likely to be slighted or even neglected, and there is need that fruit growers have a more intimate knowledge of spraying materials, spraying machinery, and especially the whys and wherefores of spraying.

The term "spraying," unfortunately, has come to have a general meaning, and it is apparent that some fruit growers do not yet understand that the kind of spray and the manner of application

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NOTE.—This bulletin gives directions for the preparation and use of the more important insecticides necessary in combating the various insect pests of orchards, vineyards, etc., as well as other information of use in preventing or reducing insect losses to these crops.

Various types of spraying apparatus, nozzles, etc., are described and illustrated, with special reference to their use in orchards and home grounds.

A ready reference table for the dilution of sprays is given (p. 75), and also a chart (fig. 34, p. 73) showing what sprays may be combined and what plants treated with given sprays.

The paper concludes with a discussion of the more important insects attacking the apple, pear, quince, peach, cherry, plum, grape, currant, and gooseberry, and gives spraying schedules for the treatment of insects and diseases of the apple, peach, and grape.

depend upon the character of insect or insects to be controlled. The up-to-date orchardist will know just what each spray application is intended to do and will realize the importance of spraying at the proper time and in the proper way. A better understanding on the part of fruit growers of the life and habits of the insect pests of their crops and of the nature of insecticides will add much to the efficiency of their work in fighting them.

There are several important insect pests, however, for which spraying does not give protection, and the control of these must not be overlooked by the orchardist. Of these the most serious are the several species of borers, which are best destroyed by systematic "worming," once or twice each year. The great desirability of keeping insects reduced by up-to-date orchard practice, as fertilization, thorough cultivation, and attention to pruning and other operations can not be emphasized too strongly, and is well appreciated by our most progressive and successful growers.

HOW INSECTS FEED.

A knowledge of the character of the mouth parts of insects is of importance to the fruit grower, for it determines the general character of sprays to be used. Broadly speaking, all insects secure their food in one of two ways: (1) By actually biting out and swallowing portions of the food material, or (2) by sucking out the juices from the

FIG. 1.—Examples of insects with biting mouth parts: *a*, Grasshopper; *b*, *e*, beetles; *c*, *d*, sawfly larvæ *f*, caterpillar.

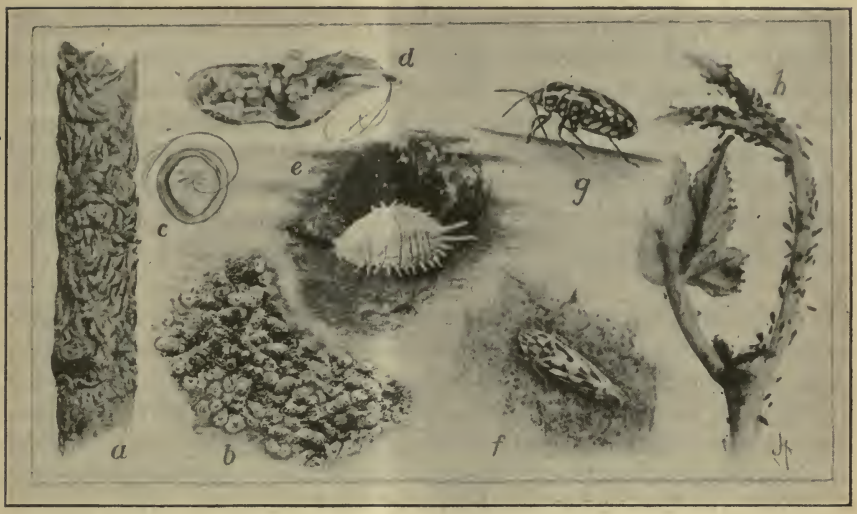

FIG. 2.—Examples of insects with sucking mouth parts: *a–e*, Scale insects; *f*, leafhopper; *g*, plant-bug; *h*, aphids.

interior portions of the host. While there are exceptions to this general statement, these are unimportant in the present connection.

Biting and sucking types of mouth parts are on two quite distinct plans. In the former there are two horny, opposable jaws, working sideways, and certain accessory appendages, with which particles of the leaf, bud, fruit, or other food substances are cut out and passed on as more or less solid particles to the food canal for digestion. This type is found in several orders of insects, as in caterpillars, or the larvæ of moths and butterflies, adult beetles and their grubs, grasshoppers, crickets, sawflies and their larvæ, bees, etc. (fig. 1). All biting insects are subject to destruction with arsenicals or other stomach poisons. Some biting insects, however, as borers and certain root-infesting forms, do not feed in situations where poisons may be applied, and for these a different treatment is necessary.

In most insects having sucking mouth parts the mandibles and maxillæ are drawn out into long setæ, or bristles, which are inclosed in a greatly modified tubelike lower lip, or beak, the four setæ and beak constituting a sucking apparatus with which juices may be drawn up from plants. Plant-lice, scale insects, leafhoppers, the pear psylla, and the true bugs, very important enemies of the fruit grower, are sucking insects (fig. 2) and for their control the so-called contact sprays are used, such as corrode the body or penetrate the breathing pores of the pests or otherwise effect their destruction.

Biting and sucking insects often occur in a way to permit of their practical destruction by poisoning the air which they breathe, as

with hydrocyanic-acid gas or carbon disulphid. The fumigation of trees with hydrocyanic-acid gas is extensively practiced in California in the destruction of scale insects infesting citrus trees, and to a less extent elsewhere. The use of this gas in the control of deciduous-fruit insects has been thoroughly investigated and discontinued, on account of its cost, in favor of spraying. Deciduous and other nursery stock, however, is now regularly fumigated by most nurserymen to guard against the possible dissemination of injurious insects (p. 43).

SPRAYING DORMANT TREES.

The spraying of trees during winter and spring, or when they are in a dormant condition, is directed largely against scale insects, especially the San Jose scale (p. 76). There are two principal advantages in spraying at this time: (1) The absence of foliage permits of more thorough applications, and (2) the sprays may be used much stronger than during the growing season. Contact sprays are employed, as lime-sulphur solution, fish-oil and other soap washes, kerosene and crude-petroleum emulsions, miscible oils, and the like. The prime essential is thoroughness in making applications, so as to cover every part of the tree, because in general only those insects actually hit with the spray are killed.

Applications may be made in late fall as soon as most of the leaves have fallen, at favorable times during the winter when the temperature is above the freezing point, or, preferably, in the spring shortly before the buds are due to swell. There is probably less danger to fruit buds and twigs from the use of sprays in the spring than at other times, especially in the case of fish-oil soap wash and the mineral-oil emulsions. Better results follow spraying with lime-sulphur solution in late spring than in late fall or during the winter, since this insures some spray on the trees during early summer, which is of value in killing any young scales, the offspring of adults which may have escaped destruction.

Spraying dormant trees for the San Jose and other scales and for other insect pests has come to be a very important part of orchard work, especially in the East and on the Pacific slope, and in general it is possible so to time this work that a single application will reach most of the troubles controllable by dormant-tree sprays. Other things being equal, the insecticide having the greatest range of usefulness should be employed. Of the several dormant-tree sprays, the standard lime-sulphur solution is the one most generally used against the San Jose scale, and it is equally effective against several other insects which may coexist on the trees. It is an excellent fungicide, and, aside from the inconvenience experienced in its preparation and its disagreeable character, it furnishes an ideal spray for

dormant trees. Abundant experience has shown it to be an effective remedy in the control of the San Jose scale (p. 76) under all conditions, and for most other diaspine scales, as the cherry scale,[1] the walnut scale,[2] the West Indian peach scale,[3] the European fruit scale,[4] and reasonably so against the oyster-shell scale (p. 76), and the scurfy scale (p. 77). Lecanium scales, such as the terrapin scale (p. 87) and the brown apricot scale,[5] are more effectively controlled by mineral-oil sprays. One thorough treatment each year, therefore, with lime-sulphur solution will keep well under control the more important scale-insect pests of the orchard.

There are certain other troubles controlled by the dormant-tree sprayings with lime-sulphur solution. It has been found effective in destroying eggs of the pear-tree psylla (p. 85) and has long been known as effective against the pear-leaf blister mite (p. 84). The red spider[6] and eggs of the clover mite[7] and other mites are probably also destroyed. In California, if applied in late spring, the lime-sulphur solution has been found effective in destroying the peach twig-borer (p. 87). Entomologists are not agreed as to the benefit from lime-sulphur spraying in the destruction of eggs of apple aphids (p. 77) and other plant-lice, but its value in this connection is perhaps not unimportant. In practice, therefore, the plan should be to make one thorough application of lime-sulphur solution to orchards each spring as a general treatment for the control not only of the San Jose scale but of many other scale insects and other pests.

SUMMER SPRAYING.

By summer spraying is meant the application of spray materials during the period of foliage. The work is directed principally against bud, leaf, and fruit eating insects, and for these arsenicals chiefly are used. Dilute contact insecticides also are employed in the control of certain insects, as aphids, red bugs, leafhoppers, etc.

The arsenicals in most general use are arsenate of lead, Paris green, and arsenate of lime. The aim is to use these about as strong as the foliage will stand without injury, though arsenate of lead may be used in unnecessarily large quantities without injury to most plants. *The foliage of stone fruits, as cherry, plum, and peach, is on the whole quite tender, and on these arsenicals must be employed with caution.* Arsenate of lead is least likely to do harm, though more than two applications, especially to peach, may cause shot-holing and dropping of leaves and burning of the fruit.

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[1] *Aspidiotus forbesi* Johnson.
[2] *Aspidiotus juglans-regiae* Comstock.
[3] *Diaspis pentagona* Targioni Tozzetti.
[4] *Diaspis ostreaeformis* Curtis.
[5] *Lecanium corni* Bouché.
[6] *Tetranychus telarius* Linnaeus.
[7] *Bryobia pratensis* Garman.

Summer spraying is now more or less universal in the case of the apple, peach, and grape, and spraying schedules have been arranged which are effective in the control of, or greatly reduce the principal insect and fungous diseases of the fruit and foliage of these crops. (See pp. 82, 90, 98.)

GENERAL CLASSIFICATION OF INSECTICIDES.

As already indicated, the important insecticides may be grouped principally into three series, as follows:

Insecticides for biting insects (*stomach poisons*).—Arsenate of lead, Paris green, arsenate of lime, arsenate of soda, arsenite of lead, arsenite of lime, arsenite of soda, Scheele's green, London purple, white arsenic, hellebore, etc.

Insecticides for sucking insects (*contact sprays*).—Lime-sulphur solution, self-boiled lime-sulphur mixture, fish-oil soap wash, kerosene emulsion, crude-petroleum emulsion, "distillate" emulsion, nicotine solution, pyrethrum, caustic soda, caustic potash, carbolic-acid emulsion, sulphur spray, resin wash, etc.

Fumigants.—Hydrocyanic-acid gas, carbon disulphid, sulphur dioxid, etc., effective against all classes of insects when it is feasible to use them.

ARSENICAL INSECTICIDES.

ARSENATE OF LEAD.

Arsenate of lead is the best known and most extensively used stomach poison for insects, and it has a wider range of usefulness than has any other internal poison now available. It is safe for use on the foliage of most plants, possesses good adhesive qualities, and, owing to its fineness, remains in suspension well in water. Moreover, it can be safely combined with certain contact sprays, as nicotine, kerosene emulsion, soaps, etc., and with a number of fungicides, such as lime-sulphur solution, self-boiled lime-sulphur mixture, and Bordeaux mixture. It should not, however, be combined with sodium or potassium sulphids.

Commercial arsenate of lead may be obtained in the paste or powdered form. The latter is coming into extended use by reason of the convenience with which it may be handled and stored and the saving in freight by the absence of water. The paste arsenate of lead, however, may be stored from year to year if properly covered with water to prevent drying and protected from freezing temperatures.

There are two principal kinds of arsenate of lead, depending upon their chemical composition: (1) That known commercially as neutral, triplumbic, or ortho-arsenate of lead; and (2) standard or acid arsenate of lead. The former is less injurious to foliage and for this reason has been recommended for use on peach, plum, etc. It should be noted, however, that it is somewhat less rapid in its killing effect than the acid arsenate of lead.

A standard for commercial arsenate of lead paste was established by the Federal insecticide act of 1910. It should contain not less than 12½ per cent of arsenic oxid, not more than ¾ of 1 per cent of water-soluble arsenic oxid, and not more than 50 per cent of water. The better grades of paste arsenate of lead now on the market contain from 15 to 17 per cent of arsenic oxid, and the powdered form of this poison usually contains from 30 to 33 per cent of arsenic oxid.

Directions for use.—Before adding paste arsenate of lead to the spray tank, it should first be mixed with water to make a thin paste. Likewise, the powdered material should be mixed with a little water or else slowly sifted into the spray tank, provided the tank is partly filled with water which is being vigorously churned by an agitator. For the control of most chewing insects which destroy deciduous-fruit crops arsenate of lead should be used at the following strengths:

Arsenate of lead, paste	pounds	2, or
Arsenate of lead, powder	pound	1
Water or fungicide	gallons	50

When smaller quantities are desired, the proportions indicated above should be observed. (See dilution table, page 75.)

HOMEMADE ARSENATE OF LEAD.

The following method for the homemade preparation of arsenate of lead will give a good product without any material waste of chemicals and will require a minimum amount of time.[1] For every pound of lead arsenate it is desired to make, use either of the following:

Formula A.

Sodium arsenate (65 per cent)	ounces	8
Lead acetate (sugar of lead)	do	22

Formula B.

Sodium arsenate (65 per cent)	ounces	8
Lead nitrate	do	18

If the sodium arsenate (p. 13) employed is 50 per cent strength, use 10½ ounces instead of 8. Of the pure crystallized salt, 14 ounces would be required to furnish the same amount of arsenic oxid as would be furnished by the given amounts of the 50 and 65 per cent grades if they actually contain these percentages. The formulas are based on lead acetate containing 60 per cent of lead oxid and lead nitrate containing 66 per cent of lead oxid. The product prepared from lead nitrate is considered slightly more desirable.

Dissolve each salt separately in from 1 to 2 gallons of water[2] (they dissolve more readily in hot water), using wooden vessels. After

[1] Haywood, J. K., and McDonnell, C. C. Lead Arsenate. U. S. Dept. Agr. Bur. Chemistry Bul. 131. 1910.

[2] The solution of lead acetate may have a milky appearance, but this is not objectionable, and it need not be filtered.

solution has taken place pour slowly about three-fourths of the lead acetate or nitrate into the sodium arsenate. Mix thoroughly and test the mixture by dipping into it a strip of potassium iodid test paper,[1] which will turn a bright yellow if lead is in excess. If the paper does not turn yellow, add more of the lead salt slowly, stirring constantly, and test from time to time. When the solution turns the paper yellow, sufficient lead salt is present, but if it should occur that the paper does not turn yellow after all the lead salt has been added, dissolve a little more and add until an excess is indicated. The great advantage of this test is that it is not necessary to filter the solution or wait for it to settle.

If the paper is not at hand, the test may be made by adding a few drops of a solution of potassium iodid, whereupon, if lead is in excess, the instant the drops touch the solution a bright yellow compound, lead iodid, will be formed.

It is very essential that the lead salt be added in *slight excess*, but *a large excess should be avoided.*

If the material has been carefully prepared with a good grade of chemicals, it will not be necessary to filter and wash the lead arsenate formed, though it would be a safe precaution to allow the lead arsenate to settle, then to decant the clear solution and to discard it. Approximately 1 pound of actual lead arsenate (on a dry basis) will be obtained by using the amounts of chemicals specified, which is equivalent to practically 2 pounds of commercial lead arsenate in the paste form. It may be made up to 50 gallons of water if a formula which calls for 2 pounds of commercial lead arsenate paste is being used; or, if a stronger application is desired, add less water.

ARSENATE OF LIME (ARSENATE OF CALCIUM).

Arsenate of calcium, or arsenate of lime, has recently come into use as an insecticide as a result of experiments by the Bureau of Entomology.[2] It is a compound somewhat similar to arsenate of lead, in which lime has been substituted for the lead.

Arsenate of lime can be profitably used for the control of chewing insects upon plants whose foliage is not tender. This poison, therefore, *should not be used on the peach, cherry, plum, or other stone fruits,* but may be used on apple, pear, grape, and many vegetables. It may be combined with lime-sulphur or Bordeaux mixture without depreciating the value of the insecticide or the fungicide.

Arsenate of lime is now obtainable on the market in both paste and powder forms. The latter, as with other commercial insecticides, is generally preferable. The powdered calcium arsenate

[1] If potassium iodid test paper can not be obtained it may be prepared by dissolving a few crystals of potassium iodid in about a tablespoonful of water and saturating filter paper or blotting paper with this solution. After the paper has dried it should be cut into strips and kept dry until needed.

[2] Scott, E. W., and Siegler, E. H. Miscellaneous Insecticide Investigations. U. S. Dept. Agr. Bul. 278, p. 47. 1915.

usually contains 42 to 46 per cent of arsenic oxid (As_2O_5), while the paste product contains approximately 17 to 20 per cent. It is not only cheaper than arsenate of lead, pound for pound, but, since it contains a higher percentage of arsenic oxid than arsenate of lead, somewhat less of the arsenate of lime is required for spraying purposes.

Directions for use.—The directions for mixing the commercial calcium arsenate preparatory to spraying are as given for commercial arsenate of lead (p. 9). For most chewing insects the amount of arsenate of lime required is:

Arsenate of lime, powder	pound..	¾, or
Arsenate of lime, paste	pounds..	2
Water or fungicide	gallons..	50

Unless arsenate of lime is used with some spray material containing lime, as lime-sulphur solution or Bordeaux mixture, it will be safer to add the milk of lime made by slaking 2 to 3 pounds of stone lime to each 50 gallons of spray. See dilution table (p. 75), for other quantities of spray.

In recent experiments,[1] it is reported that a combination of arsenate of lime and lime-sulphur, used as a summer spray for apples, caused less injury to the foliage than an equivalent strength of arsenate of lead and lime-sulphur.

HOMEMADE ARSENATE OF LIME.

The home preparation of arsenate of lime is a comparatively simple matter. With normal market prices for raw materials, the actual cost of the finished product, exclusive of labor, need not exceed 3 or 4 cents per pound for a high-grade preparation in paste form.

Arsenate of lime logically should be made from lime and arsenic acid, but the latter can not be readily obtained upon the market at this time, and hence no formula involving this material is given. It can be made from a number of other chemicals, as by combining sodium arsenate with stone lime, calcium chlorid, or calcium acetate, etc.

All things considered, the best materials for the home manufacture of calcium arsenate are high-grade fresh stone lime containing 90 per cent or over of calcium oxid, and fused (dry powdered) sodium arsenate having 65 per cent of arsenic oxid.

Directions for making.—The formula and approximate cost of ingredients are as follows:

Fresh stone lime (90 per cent CaO)	pounds..	55.	Approximate cost,	$0.30
Sodium arsenate fused (dry powdered), having 65 per cent[2] As_2O_5	do....	100.	Approximate cost,	$10.00
Water, 26 gallons	do....	208.		
Total weight of arsenate of lime	do....	363.	Total cost	$10.30

[1] G. E. Sanders. Arsenate of lead vs. arsenate of lime. Proc. Ent. Soc. Nova Scotia, No. 2, 1916, p. 40. 1917.

[2] If sodium arsenate containing 50 per cent As_2O_5 is employed, it will be necessary to use 30 per cent more than the above formula specifies.

The amounts of the ingredients in the formula may be proportionately increased or decreased to make any desired quantity of arsenate of lime.

Place the stone lime in a clean receptacle such as a 50-gallon wooden barrel. Then dissolve the sodium arsenate in boiling water and, while still hot, use this solution for starting the lime to slake; as slaking progresses add the remainder of the sodium arsenate solution, taking care not to drown the lime. During the course of the slaking it is very important to stir the contents vigorously with a hoe or other convenient implement so as to insure an even distribution of the poison. Continue the slaking, adding more water as necessary, until it is complete and a total of 26 gallons of water, including that used in dissolving the sodium arsenate, has been added. The slaking should be active so as to generate considerable heat, which will accelerate the chemical reaction.

After the arsenate of lime has cooled, a quarter-inch hole should be bored in the side of the barrel one-half inch above the surface of the contents. This hole should then be plugged and the barrel nearly filled with water and the entire contents thoroughly stirred for about 5 minutes. This is a washing process to eliminate the undesirable by-product sodium hydroxid, commonly called caustic soda. Caustic soda is injurious to foliage and unless washed out of the arsenate of lime may cause burning of the foliage. After the washing, the material should be allowed to stand overnight or for several hours in order to allow the arsenate of lime to settle. The plug should then be removed to drain off the clear liquid containing the caustic soda, and this washing should be repeated in the same manner once or twice. The product is then ready for use.

Arsenate of calcium, if properly made in accordance with the foregoing directions, should be a satisfactory poison, containing from 18 to 20 per cent of arsenic oxid and with less than one-half of 1 per cent of water-soluble arsenic oxid.

The same precautions for storing arsenate of lead paste apply to the paste arsenate of lime. It should be kept covered with sufficient water to prevent drying, and it should be protected against freezing.

Directions for use.—This insecticide is for use on hardy foliage, as that of the apple, pear, and other pome fruits, grape, etc., but should not be used on plants having tender foliage such as the stone fruits, like peach, cherry, and plum. For most chewing insects, apply the homemade arsenate of calcium at the following rate:

Arsenate of lime (homemade paste)	pounds..	2
Water or fungicide	gallons..	50

For the use of the homemade arsenate of lime when not combined with a spray material containing lime, see directions for use of the commercial product (p. 11).

ARSENATE OF SODA.[1]

Arsenate of soda is a very poisonous compound of arsenic, but, as it is soluble in water, it is very destructive to foliage and can not be used for spraying purposes. When properly combined with an insoluble base, as lead (p. 8) and lime (p. 10), the insoluble compounds arsenate of lead and arsenate of lime are formed, both of which are useful spray materials. The grade of arsenate of soda generally employed in making arsenical insecticides at home is that known as technically pure, dry fused (powdered) arsenate of soda containing 65 per cent of arsenic oxid ($As_2 O_5$).

PARIS GREEN.

Paris green is an arsenical compound, the aceto-arsenite of copper, and was one of the first poisons used in America for the destruction of chewing insects. Paris green has been widely and extensively employed in the past, but in orchard spraying more recently has been largely superseded by arsenate of lead and other compounds.

Commercial Paris green should be finely ground, and, as specified by the insecticide act of 1910, should contain not less than 50 per cent of arsenious oxid and not more than 3½ per cent of water-soluble arsenic. It is a heavy substance, and it is therefore necessary to have thorough agitation in order to secure even distribution of the poison when applied as a liquid spray. It is not so adhesive as arsenate of lead, though when used in Bordeaux mixture this objection loses much of its force.

Paris green should never be used on stone fruits, such as peaches, cherries, or plums. When used on apples, pears, grapes, or foliage having similar resistance to arsenical scorching, Paris green should be combined with either Bordeaux mixture or milk of lime. It should not be mixed with lime-sulphur solutions.

Liquid application of Paris green.

Paris green	ounces..	6
Stone lime (slaked) [2]	pounds..	2 to 3
Water or Bordeaux mixture	gallons..	50

The amount of Paris green for other quantities of spray is given on page 75.

Dry application of Paris green.

Paris green	pound..	½
Lime (air slaked) or flour	pounds..	3

For smaller or larger quantities the same proportions should be observed.

[1] Potassium arsenate is a very similar compound, but, owing to its higher cost, is not extensively used for insecticidal purposes.

[2] If used in Bordeaux mixture, the lime is unnecessary.

SCHEELE'S GREEN (GREEN ARSENOID).

Scheele's green is a compound of copper and arsenic. This arsenical is generally a finer powder than Paris green and was at one time used more or less as a substitute for Paris green. It is employed in the same proportions and in the same way as Paris green.

ARSENITE OF LIME.

Arsenite of lime is a relatively cheap compound of lime and white arsenic and has been used for a great many years as a substitute for Paris green. Its use is frequently attended with foliage injury and for this reason it is not a safe spray material. Arsenite of lime should not be confused with the spray compound known as arsenate of lime or calcium arsenate (p. 10).

Arsenite of lime, if properly made and used under favorable conditions, can be applied with relative safety upon foliage which is highly resistant to arsenical injury. This compound also may be used as the poisonous ingredient in insect baits. It is prepared as follows:

White arsenic	pounds	2
Sal soda crystals	do	2
Water	gallons	1 to 1½

Boil the ingredients together until thoroughly dissolved, which will require about 15 to 20 minutes. The resulting compound is sodium arsenite in solution, and this solution should be used to slake 3 to 4 pounds of fresh stone lime. After the slaking is complete add sufficient water to bring the product, arsenite of lime, up to a total of 2 gallons. This should be stored in a jug or other tight receptacle. When ready to use, stir thoroughly and add 1 quart to each 50 gallons of spray material and milk of lime made from slaking 3 to 4 pounds of stone lime. When used in Bordeaux mixture, the milk of lime is unnecessary.

ARSENITE OF ZINC.

Arsenite of zinc was introduced upon the market a few years ago in both paste and powder forms. The powdered arsenite of zinc usually contains slightly over 40 per cent of arsenious oxid. In common with other arsenious compounds, arsenite of zinc is an active poison, but it can not be used with safety except on very resistant plants. The danger of burning is reduced when this poison is combined with milk of lime or Bordeaux mixture. Arsenite of zinc (powder) is generally used at the rate of ¾ pound to each 50 gallons, while the paste material is used in the proportion of 1½ pounds to each 50 gallons of spray.

ARSENITE OF LEAD.

This compound should not be confused with arsenate of lead (p. 8), since it is an entirely different product. Arsenite of lead is seldom used in orchard work, on account of its caustic properties.

LONDON PURPLE.

London purple is a by-product in the manufacture of anilin dyes and contains a variable amount of arsenite of lime. It was formerly used as a substitute for Paris green, but owing to its variable composition, its water-soluble arsenic content, and the resultant injury to the plant foliage, London purple is now seldom used in orchard spraying.

WHITE ARSENIC (ARSENIC TRIOXID).

White arsenic is an exceedingly active stomach poison and is generally employed in the manufacture of the arsenical poisons now in use. Owing to its causticity it can not be used as a spray material without severe burning of the foliage. White arsenic is used to some extent as a poison in insect baits.

ARSENICAL INSECT BAITS.

Poisoned baits have proved very valuable for emergency purposes, especially to combat serious outbreaks of grasshoppers, cutworms, etc. These insects often defoliate fruit trees, although grasses and grains usually suffer the most from them.

Insect baits made according to several formulas have been recommended, but those composed of poisoned bran sweetened with a sirup, or of poisoned horse manure, have been most extensively employed. An insect bait containing lemon juice has proved its superiority over all other baits for the destruction of grasshoppers. The formula for this bait is best presented in two parts:

Part 1.

Paris green (or white arsenic)	pounds..	2½, or ounces..	4
Bran	do....	50, or pounds..	5

Part 2.

Lemons (pulp and rind finely chopped)		6, or lemon..	1
Sirup	gallon..	1, or pint..	¾
Water	gallons..	5, or quarts..	2

Mix thoroughly the ingredients of part 1; next mix together the materials of part 2, first adding to the water the lemon juice and the pulp and rind finely chopped, and finally the sirup. When ready to use, mix thoroughly the ingredients of parts 1 and 2 and add sufficient water to make a wet mash. The mash should be thoroughly scattered broadcast early in the morning, preferably when the soil is damp, at the rate of 3 to 5 pounds per acre. In arid regions the mash should be scattered along damp irrigation laterals, since it hardens and when dry is not eaten by the insects.

Another insect bait, commonly known as the "Criddle mixture," is made in accordance with the following formula:

Paris green	pound	1
Common salt	pounds	2
Fresh horse dung	do	60

This mixture is for use against grasshoppers, cutworms, and army worms, and is cheaper than the bran mash above indicated, but is not so effective.

HELLEBORE.

Hellebore is the powdered roots of the white hellebore plant.[1] It contains alkaloids which are poisonous to insects but which, in the quantities properly used for insecticides, do not seriously affect man. For this reason it may be used to protect from injury by chewing insects fruit that is about to ripen. This material, however, is used only for small-scale operations, as it can not be profitably employed where many plants are to be treated.

Liquid application:			Dry application:		
Hellebore	ounce	1	Hellebore	ounce	1
Water	gallon	1	Flour (or air-slaked lime), ounces		5 to 10

POWDERS FOR DUSTING.

Insecticides and fungicides in dry or powdered form have long been used in insect and disease control, especially on low-growing plants. At different times interest has been manifested in the use of dusts for the control of these troubles in orchards and vineyards, and extensive experiments have been made to determine the efficacy of such treatments. The dusts used in orchards until recently were mostly composed of powdered Bordeaux mixture and Paris green. These dusts, on the whole, did not prove satisfactory substitutes for spraying and were little used, except under unusual orchard conditions. Recently interest in dusting orchards as a substitute for spraying has been revived. The materials now employed are finely powdered arsenate of lead and very finely divided sulphur with a diluent or filler, as hydrated lime or gypsum.

Sufficient experimental work has not yet been done with the new dust materials to show definitely their value in the control of the various insects and diseases of the orchard and vineyard under variable weather and climatic conditions. The conservative orchardist will continue to use liquid sprays until the status of dust sprays has been more fully determined. Under special conditions, however, as in case of very hilly orchards or where the water supply is not at all convenient, the dusting method proves useful.

[1] *Veratrum album.* Our native plant, *V. viridis*, possesses about the same insecticidal properties as white hellebore, and is now being much used for insecticidal purposes.

Several formulas for dusts have been proposed by experimenters, and various mixtures have been placed on the market. Three formulas are given for the benefit of those interested in the subject.

Formula A.

Arsenate of lead, powder	per cent..	10 to 15
Sulphur, superfine	do....	90 to 85

This is for use where chewing insects and fungous diseases are equally abundant.

Formula B.

Arsenate of lead, powder	per cent..	10
Sulphur, superfine	do....	50
Filler	do....	40

This formula, owing to the use of a filler, is somewhat cheaper than formula A, and is intended for use where fungous diseases are only moderately troublesome.

Formula C.

Arsenate of lead, powder	per cent..	10 to 15
Filler	do....	90 to 85

This is for chewing insects only, in regions where fungous diseases are not present.

Amount of dust material required.—Under average conditions about 2 pounds of the dust mixture will cover the same tree area as 10 gallons of liquid spray. The amount of dust necessary for thorough work, however, will vary somewhat, depending upon air currents and whether these are variable or uniform in direction, the size and shape of the trees, the distance between the trees, and other factors.

Applying the dust.—The dust material should be applied during very calm weather, as it is practically impossible to treat an orchard properly when the wind is strong. Small trees sometimes may be well treated by dusting from one side only, but it is essential that trees of moderate to large size be dusted from two sides in order that the powder may cover them properly. As a general practice it is better to dust rapidly from two sides than to work slowly from one side. It is not necessary to apply the dust when the trees are wet with dew or rains, as the dust material will adhere to the dry foliage.

Preparation of the dust.—Dusts are readily made at home by weighing out the desired quantities of the respective ingredients and passing them through a mixing machine. For small-scale work the mixing may be done by hand. *Dusts are to be used only on trees when in foliage.* For dormant tree treatment of the San Jose and other scales, sprays must be used.

LIME-SULPHUR SPRAYS AND OTHER SULPHUR INSECTICIDES.

As stated elsewhere, lime-sulphur sprays have become the main reliance in the control of the San Jose and certain other scales and are effective in controlling numerous other insects. When the lime-sulphur solution is properly diluted it is a very valuable fungicide for use on hardy trees in foliage, and at the same time will destroy many of the newly hatched San Jose and other scale insects. As a summer spray it may be combined with arsenate of lead and nicotine for the simultaneous control of many chewing and sucking insects and fungous diseases. *Lime-sulphur solution should not be used with soap.*

OLD FORMULA.

Several years ago the cooked lime-sulphur wash was used largely for the control of the San Jose scale but has now been generally superseded by the commercial or homemade concentrates. Since inquiry occasionally is received as to its preparation, the old formula and method of making are given below:

Stone lime	pounds	20 or 2
Sulphur (commercial ground)	do	15 or 1½
Water to make	gallons	50 or 5

Heat in a cooking barrel or vessel about one-third of the total quantity of water required. When the water is hot, add all the lime and at once add all the sulphur, which previously should have been made into a thick paste with water. After the lime has slaked, about another third of the water, preferably hot, should be added, and the cooking should be continued for one hour, when the final dilution may be made, using either hot or cold water, as is most convenient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in kettles. If cooked by steam, no stirring will be necessary. After the wash has been prepared it must be well strained as it is being run into the spray tank. It may be cooked in large kettles, or preferably by steam in barrels or tanks. This wash should be applied promptly after preparation, since, as made by this formula, there is crystallization of the sulphur compounds and consequent hardening of the sediment upon cooling.

COMMERCIAL LIME-SULPHUR CONCENTRATES.

For a number of years manufacturers have had on the market concentrated solutions of lime-sulphur which have only to be diluted with water for use. These commercial preparations, if used at proper strength, have proved to be entirely satisfactory. Although somewhat more expensive than washes made according to the old formula, many commercial orchardists have adopted the commer-

cial concentrates in preference to making the wash at home. Where only a limited amount of spraying is to be done, as in the average home orchard, it will be especially convenient to use the commercial concentrates. Lime-sulphur concentrates usually may be purchased from local seedsmen, implement dealers, or druggists, and from the manufacturers. They should have a density of about 33° on the Baumé scale and at this strength should be used as follows:

For dormant trees, 6¼ gallons to make 50 gallons of spray, or 5 pints to make 5 gallons of spray.

For hardy trees in foliage, 1½ gallons to make 50 gallons of spray, or 1¼ pints to make 5 gallons of spray.

For other dilutions see page 75.

HOMEMADE LIME-SULPHUR CONCENTRATES.

The question of the preparation at home of lime-sulphur concentrate which will not crystallize upon cooling, thus duplicating the commercial product, has been investigated by the Bureau of Entomology of the United States Department of Agriculture, as well as by numerous experiment-station entomologists, notably by Profs. Stewart, Cordley, Parrott, and others. It has been demonstrated that it is practicable for orchardists to prepare concentrated stock solutions of lime-sulphur for immediate or later use, and since there is a saving in costs, many orchardists employ this plan. The necessary details for the preparation at home of lime-sulphur concentrates are given below.

MATERIALS FOR MAKING.

Lime.—Use freshly burned stone lime, containing 90 per cent or over of calcium oxid. Hydrated lime, although not so desirable, may be substituted for the stone lime. If this form is used, it will be necessary to increase the amount of lime specified in the formula by at least one-third.

Sulphur.—Commercial sulphur, finely ground, is recommended. It is unnecessary to use the more expensive (sublimated) flowers of sulphur.

EQUIPMENT FOR MAKING.

Cooking apparatus.—Lime-sulphur concentrate may be made by orchardists with very simple appliances, such as a large kettle suspended on a pole or raised from the ground on loose stones. One or two such kettles embedded in masonry would be more convenient, however, and, being permanent, would warrant the installation of a convenient water supply. (See fig. 3.) Ordinary feed cookers or jacketed kettles are also very satisfactory. Small steam boilers of a few horsepower capacity serve especially well for a medium-sized orchard.

Where the amount of concentrate to be made is considerable, as for a large orchard or for the fruit growers of a neighborhood, it will pay to construct a more elaborate cooking plant. A convenient outfit is shown in figure 4. In the construction of these plants careful attention should be given to the arrangement of the cooking vessel, the water supply, and the arrangement for drawing off the cooked wash. A 12-horsepower boiler will furnish sufficient steam for a cooker of 300 gallons capacity. If a steam engine is to be used for running the agitator, however, a somewhat larger boiler will be necessary. The cooking vessel may be either of wood or iron, though an iron vessel is usually more satisfactory owing to the difficulty in preventing leakage of wooden vessels. If the cooking vessel is not provided with a pump it should be so elevated that the cooked concentrate may be drawn off by gravity into a settling tank or storage vessels. Vinegar barrels, or barrels which have been

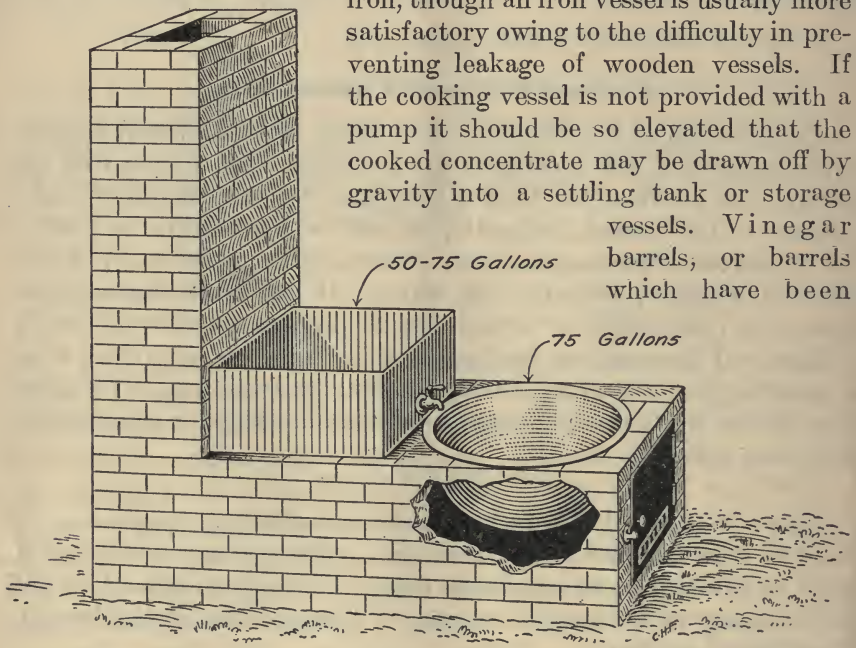

FIG. 3.—Lime-sulphur cooking outfit for preparing wash for small to medium-size orchards.

used for acids, should not be employed in storing the solution, as the acid breaks down the concentrate. Kerosene-oil barrels and whisky barrels are used to a large extent.

Measuring stick.—When lime-sulphur concentrate is made on a small scale, a measuring stick will be of service in determining the amount of solution at any time during the cooking process. A suitable measuring device may be made from a strong strip of wood, the edges of which are plainly notched to indicate the number of gallons.

Hydrometer.—A glass instrument known as a hydrometer (fig. 6), is used to determine the density of the lime-sulphur concentrate. (See p. 24.)

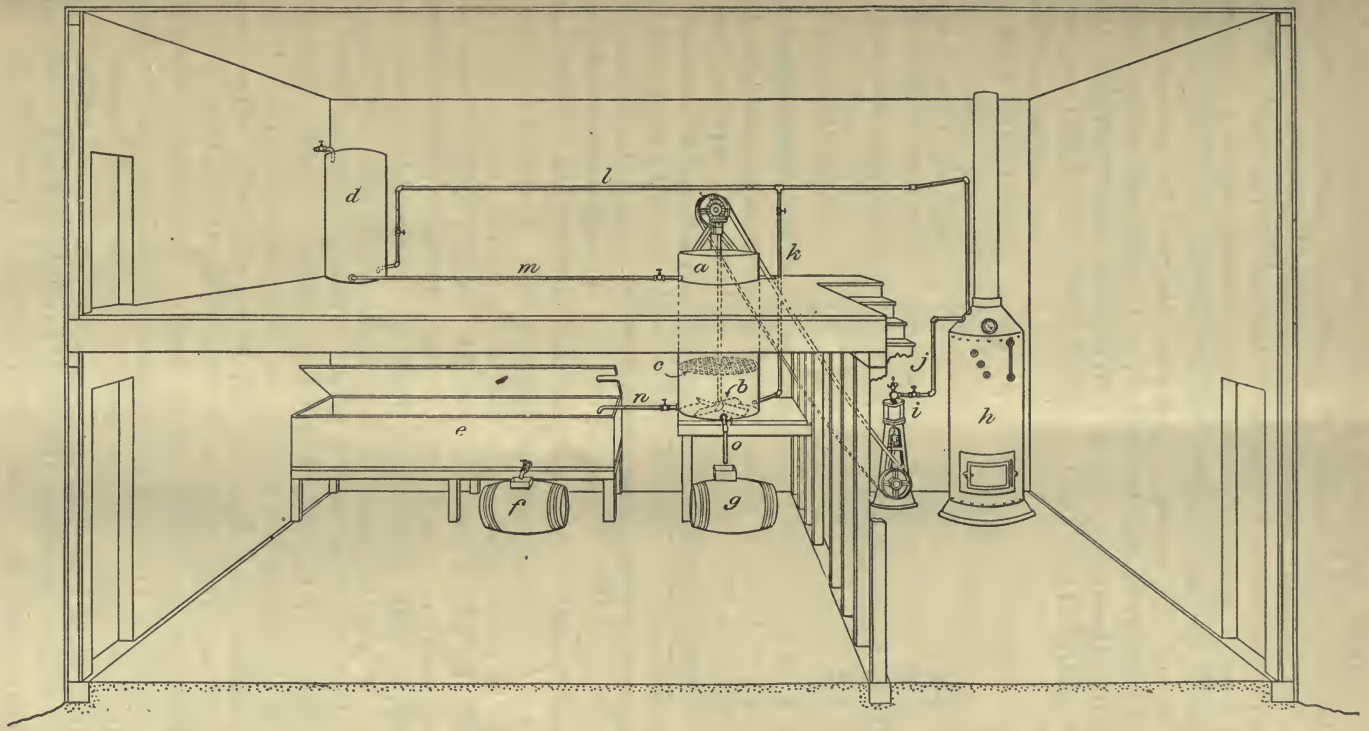

FIG. 4.—Diagrammatic representation of arrangement of parts in a large lime-sulphur cooking plant; *a*, Cooking tank; *b*, agitator; *c*, screen for support of lime and sulphur; *d*, water supply tank; *e*, settling tank; *f*, barrel for storing the lime-sulphur concentrate; *g*, same when concentrate is drawn directly from cooking vessel; *h*, steam boiler; *i*, steam engine for running agitator; *j*, steam pipe from boiler to engine; *k*, steam pipe for cooking the lime-sulphur concentrate; *l*, steam pipe for heating water in water supply tank; *m*, pipe from water supply tank to cooking vat; *n*, pipe and valve for drawing off concentrate from cooking vat to settling tank; *o*, pipe and valve for drawing off concentrate from cooking vat directly to storage barrel.

Strainer.—After the lime-sulphur has been made it should be strained before storage in order to remove the coarser undissolved particles. Any kind of a strainer having either brass or tinned iron wire (*never copper*), 30 to 50 meshes to the inch may be used. With the usual type of strainer, however, the sediment will clog the wire mesh more or less and thereby will prevent the rapid flow of the solution through the screen. A strainer designed to overcome the clogging of the screen may be made upon the principle of the model shown in the illustration (fig. 5). With this type of strainer the material is poured in at A and is strained upward through the screen. The coarse particles settle to the bottom of the strainer, instead of lodging on the screen as in the ordinary type of strainer.

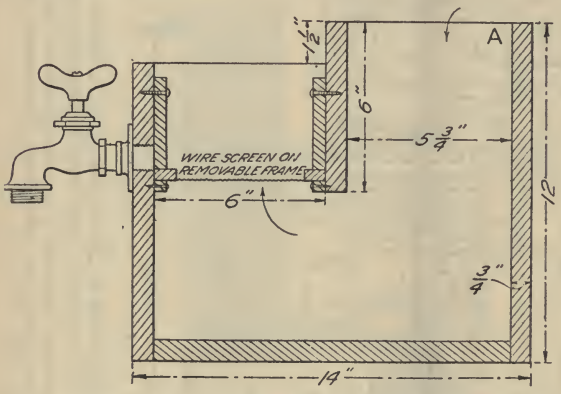

FIG. 5.—Strainer for removing sludge in lime-sulphur concentrate and other sprays.

HANDLING AND STORAGE.

It is very desirable in most cases to make up a supply of lime-sulphur solution during the winter or early spring, before spraying operations begin. It is quite feasible to do this, as the concentrated solution can be kept a year or more when properly stored. It should be placed in barrels or other tight receptacles and carefully stoppered so as to exclude the air as much as possible, as this slowly causes the wash to deteriorate. The barrels or other container should be filled completely, so that there will be little or no air space above the contents. If the container is not filled completely, the concentrate should be covered with a layer of heavy oil or paraffin. In the preparation of the lime-sulphur concentrate at home the disposition of the sludge is a question of practical importance. Commercial manufacturing plants are usually supplied with a filter press by means of which the wash, as it comes from the cooking tank, is filtered, freeing it from sludge and sediment. There seems, however, to be no objection to storing the solution without removal of sludge, though the sediment should be strained out as already stated.

The strength of lime-sulphur concentrate may not be affected by freezing but the expansion of the solution would be likely to damage the storage receptacles. It does not freeze easily, however, and the

temperature at which it freezes varies with its strength; the stronger the solution the less easily it is frozen. It will stand a considerably lower temperature without freezing than will water.

FORMULAS.[1]

There are two general formulas, either of which may be used:

Formula A.

Fresh stone lime	pounds..	50, or 5
Commercial ground sulphur	do....	100, or 10
Water to make finished product	gallons..	50, or 5

Formula B.

Fresh stone lime	pounds..	80, or 8
Sulphur (commercial ground)	do....	160, or 16
Water to make finished product	gallons..	50, or 5

The density of the concentrate, made according to formula A, has varied, in the experience of the Bureau of Entomology, from 24° to 28° Baumé, and theoretically should be 26° by this scale. It is quite desirable, for economy in storage space, to prepare as highly concentrated a solution as possible. This can be done with reduced quantity of water according to formula B, which will give a solution of a density of from 32° to 34° Baumé. While this formula gives about 50 per cent in volume of sludge, after allowing the solution to settle for 24 hours, there is only about 5 to 10 per cent in volume of insoluble material, which would be removed in the straining process. This volume of sludge will not be objectionable in spraying, provided the insoluble material has been properly strained out.

DIRECTIONS FOR PREPARATION.

To make a 50-gallon batch of the lime-sulphur concentrate proceed in the following manner:

Place 10 gallons of water in the cooking vessel and start the fire or release the steam. Weigh out the lime and sulphur. The sulphur may be used dry, provided all the lumps are broken, or it may be made into a thin paste, and may be placed in the cooker before or after the lime has started to slake. When slaking is under way the materials must be stirred vigorously, and this agitation should be continued now and then throughout the boiling. Continue adding water, as required, until the lime is slaked; then, if cooking by fire, bring the contents up to 55 gallons and boil for 50 minutes to one hour. When steam is employed fill the cooker up to the 50-gallon mark. No excess water is needed since the condensation of the steam about equalizes the amount of water lost through evaporation. The finished product should measure 50 gallons.

[1] Scott, E. W. Homemade lime-sulphur concentrate. U. S. Dept. Agr. Bul. 197. 1915.

DILUTION.

It is very important to test with a hydrometer (fig. 6) the strength of all lime-sulphur solutions, to determine the proper amount of the concentrate that should be used for a given quantity of water. There are two kinds of these hydrometers, one with the Baumé scale and the other with the specific-gravity scale, and hydrometers may be purchased which have both scales on the same instrument. The Baumé scale hydrometer is most commonly used. The clear solution at a temperature of about 60° F. should be used for the testing. If, however, the sludge has not been filtered out, the contents of the barrel or other container should be thoroughly stirred before the required amount for testing is taken out. The amount of dilution for concentrates for each degree Baumé from 20 to 36, and the corresponding specific-gravity reading, can be determined from Table I.

TABLE I.—*Dilution table for concentrated lime-sulphur solutions.*

Degrees Baumé.	Specific gravity.	Number gallons concentrated lime-sulphur to make 50 gallons spray solution.			Degrees Baumé.	Specific gravity.	Number gallons concentrated lime-sulphur to make 50 gallons spray solution.		
		Summer or foliage strength.	Winter or dormant strength.				Summer or foliage strength.	Winter or dormant strength.	
			San Jose scale.	Blister mite.				San Jose scale.	Blister mite.
36	1.330	1¼	5¼	4¾	27	1.229	2	8	6¾
35	1.318	1¼	5¾	5	26	1.218	2	8¼	7¼
34	1.306	1½	6	5	25	1.208	2	8¾	7½
33	1.295	1½	6¼	5¼	24	1.198	2¼	9¼	8
32	1.283	1½	6½	5½	23	1.188	2¼	9¾	8¼
31	1.272	1¾	6¾	5¾	22	1.179	2½	10¼	8¾
30	1.261	1¾	7	6	21	1.169	2½	11	9¼
29	1.250	1¾	7¼	6¼	20	1.160	2½	11½	9¾
28	1.239	1¾	7½	6½					

In winter spraying for the San Jose scale and the pear-leaf blister mite about 5 per cent more of the solution should be used than the table of dilutions indicates, if the sludge has not been filtered out. In summer spraying, however, no allowance for sludge is necessary, as a large percentage of this is composed of finely divided sulphur, which is of value.

LIME-SULPHUR SOLUTIONS FOR SUMMER SPRAYING OF POME FRUITS.

The discussion of lime-sulphur solutions on the preceding pages has related to their use on trees in a dormant condition. It sometimes happens that owing to unfavorable weather conditions during the time of the dormant spraying, or for other reasons, the application was not made satisfactorily, and it becomes desirable to spray the trees during the summer.

Under these circumstances much benefit will follow summer spraying for the San Jose scale, but this work should be regarded as

a temporary expedient to prevent undue increase of the insect until the more effective dormant treatment may be applied.

Either the commercial or homemade lime-sulphur concentrate may be used for summer spraying (except on stone fruits), but they must be used in a much more dilute condition than during the winter. The dilute lime-sulphur solution has come into very extended use as a fungicide [1] and is used on pome fruits at the rate of 1½ gallons of the concentrate, registering from 32° to 34° on the Baumé scale, to 50 gallons of water. The use of the lime-sulphur solution as a fungicide will assist much in controlling the scale, provided attention is given in spraying to coat, in addition to the leaves and fruit, the limbs, branches, and twigs.

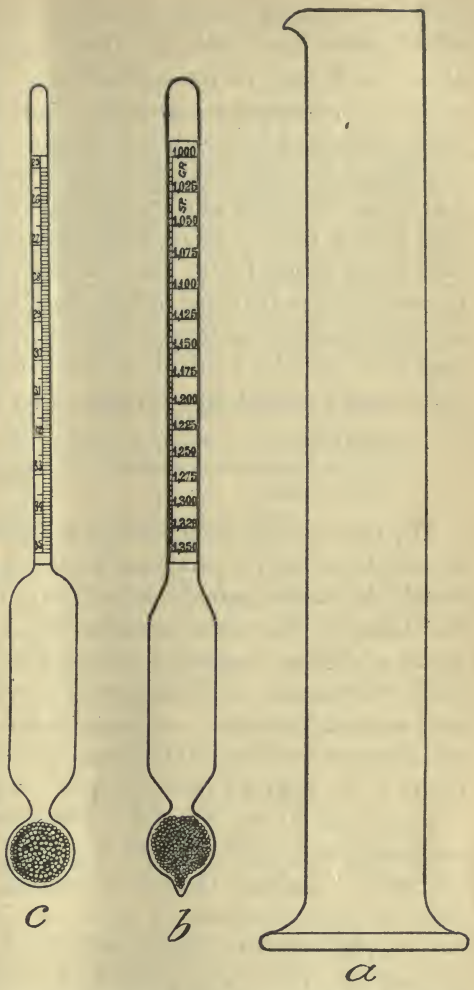

FIG. 6.—Apparatus for determining specific gravity of lime-sulphur concentrate: *a*, Cylinder for liquid to be tested; *b*, specific gravity spindle; *c*, Baumé spindle.

Young scale insects from individuals which may have escaped the dormant treatment have a decided tendency to migrate onto the fruit. The presence of these insects on the fruit is very objectionable, especially on apples intended for export trade, as scale-infested fruit is excluded from entry by certain foreign Governments, and is discriminated against by buyers generally. The summer use of the diluted lime-sulphur spray largely protects the fruit against the young scale insects.

SELF-BOILED LIME-SULPHUR MIXTURE FOR SUMMER SPRAYING OF STONE FRUITS.

Summer spraying of peach trees and other stone fruits for the San Jose and similar scale insects may also be desirable because of ineffec-

[1] Quaintance, A. L., and Scott, W. M. The more important insect and fungous enemies of the fruit and foliage of the apple. U. S. Dept. Agr. Farmers' Bul. 492. 1912.

tive work during the dormant period of the trees. Under such circumstances the self-boiled lime-sulphur mixture should be used, since the foliage of the stone fruits will not stand the diluted lime-sulphur concentrate previously indicated for the apple, pear, etc. This self-boiled lime-sulphur mixture is made up according to quite a different formula from any of the washes heretofore mentioned, and has come into general use as a fungicide for the control of peach scab and brown rot.[1] Orchardists spraying for these troubles on peaches and other stone fruits may at the same time accomplish much in preventing the increase of the scale by thoroughly coating the limbs and branches of the trees while making the applications to the foliage and fruit for the control of the fungous troubles mentioned. The self-boiled lime-sulphur mixture may be made as follows:

Stone lime	pounds..	8, or 2
Sulphur (commercial ground[2] or flowers)	do....	8, or 2
Water to make	gallons..	50, or 12½

The lime should be placed in a barrel and enough water poured on almost to cover it. As soon as the lime begins to slake the sulphur should be added, after first running it through a sieve to break up the lumps. The mixture should be stirred constantly and more water added as needed to form a thick paste at first and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as it is well slaked cold water should be added to cool the mixture and prevent further cooking. It is then ready to be strained into the spray tank, diluted, and applied.

The stage at which cold water should be poured on to stop the cooking varies with different grades of lime. Some limes are so sluggish in slaking that it is difficult to obtain enough heat from them to cook the mixture at all, while other limes become intensely hot on slaking, and care must be taken not to allow the boiling to proceed too far. If the mixture is allowed to remain hot 15 or 20 minutes after the slaking is completed the sulphur gradually goes into solution, combining with the lime to form sulphids, which are injurious to peach foliage. It is therefore very important, especially with hot lime, to cool the mixture quickly by adding a few buckets of water as soon as the lumps of lime have slaked down. The intense heat, violent boiling, and constant stirring result in a uniform mixture of finely divided sulphur and lime, with only a very small percentage of the sulphur in solution. It should be strained to take out the coarse particles of lime, but the sulphur should be carefully worked through a strainer. The mixture can be prepared in larger quantities if desired, say enough for 200 gallons at a time, making the formula 32 pounds of lime and 32 pounds of sulphur to be slaked

[1] Scott, W. M., and Quaintance, A. L. Spraying peaches for the control of brown-rot, scab, and curculio. U. S. Dept. Agr. Farmers' Bul. 440. 1911.

[2] Commercial ground sulphur is the cheaper and is equally as satisfactory as the flowers of sulphur.

with a small quantity of water (8 or 10 gallons) and then diluted to 200 gallons. To make other quantities of the mixture see dilution table (p. 75).

COMMERCIAL POWDERED SULPHUR COMPOUNDS.

Within the past few years certain manufacturers have offered for sale, in a dry powdered condition, compounds of sulphur which are to be dissolved in water for the preparation of the spray. These compounds give promise of being satisfactory as dormant tree sprays and certain of them as summer sprays, and if so will undoubtedly meet with prompt favor with orchardists, since by their use there is a distinct saving in freight, and they are much more convenient in handling and storing.

In their use the directions on the label should be followed. *Arsenicals should not be added to soda or potash sulphid sprays on account of the danger of burning the foliage.*

HOMEMADE SODIUM SULPHID CONCENTRATE.

Sodium sulphid concentrate may be readily made at home. A spray made according to the following formula has given fairly satisfactory results as a dormant treatment for the San Jose scale, but is not equal to lime-sulphur concentrate. In the experience of the Bureau of Entomology, this spray is more easily washed off by rains than lime-sulphur solution. *It is not advised, even greatly diluted, for summer spraying, and arsenicals should not be used with it.*

Caustic soda (commercial ground, 90 per cent or over), pounds	11,	or 1. 1
Sulphur (commercial ground) pounds	12½,	or 1. 2
Water to make finished product gallons	50,	or 5

To make 50 gallons, mix the sulphur into a paste with 4 to 5 gallons of boiling water. Immediately add the caustic soda and stir occasionally for a half hour or so or until the ingredients have gone into solution. The material is then ready for dormant spraying when diluted with water to make a total of 50 gallons.

SULPHUR.

Sulphur, in powdered form, is employed for the destruction of the red spider and other mites on plants in foliage. Commercial ground sulphur may be used and, if finely powdered, will be as effective as the more expensive flowers or sublimated sulphur. The sulphur may be used either pure in dry form or diluted with equal parts of a carrier such as hydrated lime, gypsum, flour, etc. When only a few plants or trees are to be treated, a small hand duster (fig. 26, p. 67) is sufficient, though larger apparatus (fig. 27, p. 68) will be needed for orchard work. The sulphur may be applied as a liquid

spray, used at the rate of 10 pounds to 50 gallons of water. When applied in water, the sulphur should first be made into a paste, soapy water being used to facilitate the mixing. About 2 pounds of soap should be used to each 50 gallons of spray to aid in the even distribution of the sulphur throughout the water and to increase the spreading power of the spray on the foliage.

PETROLEUM-OIL SPRAYS.

Under the heading "Petroleum-oil sprays" are included kerosene and crude petroleum, either pure or in emulsion, the distillates, the so-called miscible oils, creosote-oil emulsion, and carbolic-acid emulsion.

PURE KEROSENE.

Pure kerosene has been recommended to a greater or less extent for spraying dormant trees badly infested with the San Jose and other scales, but it has never been very generally employed. There is no question of the efficacy of such an application in the destruction of the insects, but the great danger of injury to the plants precludes its general use. Treatments of pure kerosene should be applied through a nozzle with a very fine aperture. Only the minimum amount of kerosene necessary to cover the trees should be given, and care is necessary that the liquid does not puddle around the roots of the trees. *Applications should be made only on bright days.*

KEROSENE EMULSION.

Kerosene emulsion has long served as a standard spray for the control of soft-bodied sucking insects. If well made and properly diluted, kerosene emulsion will give satisfactory results. *It should never be combined with lime-sulphur.*

A good stock solution of kerosene emulsion containing 66 per cent of oil may be made according to the following formula:

Kerosene (coal oil, lamp oil)	gallons..	2
Fish-oil or laundry soap (or 1 quart soft soap)	pound..	½
Water	gallon..	1

First dissolve the soap in boiling water; then remove the vessel from the fire. Immediately add the kerosene, and thoroughly agitate the mixture until a creamy solution results. The stock solution may be more conveniently made by pouring the mixture into the tank of a spray pump and pumping the liquid through the nozzle back into the tank for some minutes. The stock solution, if properly made, should last for some time, but it is better to make it up as needed. Do not dilute until ready to use. To make a 10 per cent spray (the strength for trees in foliage) add, for each gallon of the stock solution, about 5⅔ gallons of water. For 20 and 25 per cent emulsions (for use on dormant trees and plants) use, respectively, about 2⅓ and 1⅔ gallons

of water for each gallon of stock solution. Agitate the mixture in all cases after adding the water. (See dilution table, p. 75).

The preparation of the emulsion may be simplified by the use of a naphtha soap. No heat will be required, as the kerosene will combine readily with the naphtha soap in water, when thoroughly agitated. If naphtha soap is used, twice as much will be required as is given for the other kinds of soap in the foregoing formula, and soft or rain water should be used in making the emulsion. In regions where the water is "hard" this should first be "broken" with a little caustic potash or soda, or common lye, before use for dilution, to prevent the soap from combining with the lime or magnesia present, thus liberating some of the kerosene; or rain water may be employed.

CRUDE-PETROLEUM EMULSION.

Eastern crude oil.—Crude-petroleum emulsion may be prepared in identically the same way as has been described for kerosene emulsion, crude petroleum being substituted for kerosene. The grade of petroleum employed in the East is that known as "insecticide oil," having a density on the Baumé scale of 43° to 45°. The same dilutions for winter and summer spraying should be observed as given for kerosene emulsion, but it should be noted that for treatment of trees in foliage the kerosene emulsion is preferable, as it is less likely to cause injury.

Western crude oil.—In California and elsewhere on the Pacific Coast a crude-oil emulsion at 12 per cent strength is used as a dormant spray, particularly for the control of the European fruit lecanium and the European pear scale, and for the destruction of lichens. In the preparation of this emulsion a natural oil (asphalt base) direct from the wells, running 16° to 22° Baumé, should be used. Fish-oil soap may be used as an emulsifier, and this may be made according to the directions given on page 36, or the commercial article may be employed. The emulsion, as needed for use, ordinarily is made in the spray tank according to the following formula:[1]

Fish-oil soap	pounds..	20
Lye	do....	4
Western crude oil (16° to 22° Baumé)	gallons..	24
Water	do....	176

Dissolve the soap in 10 to 15 gallons of boiling water and pour into the spray tank, and then add the lye and enough water to bring the contents up to the 176-gallon mark. Start the agitator and slowly pour in the crude oil. Do not add any water after the oil has been added. Continue the agitation for a few minutes, and the emulsion is ready for application to the trees.

[1] Jones, P. R. Tests of sprays against the European fruit lecanium and the European pear scale. U. S. Dept. Agr. Bur. Ent. Bul. 80, Part VIII. 1910.

It is sometimes inconvenient to boil the water for dissolving the fish-oil soap, in which case the formula given below will be satisfactory:

Lye	pounds	5
Oleic acid	gallon	1
Western crude oil (16° to 22° Baumé)	gallons	24
Water	do	175

Pour 175 gallons of water into the spray tank and start the agitator, then add the lye; as soon as dissolved add the oleic acid. This will result in a soapy mixture. Next pour in slowly the crude oil. When the emulsion is complete it is ready for application.

DISTILLATE-OIL EMULSION.

For the control of the pear thrips (p. 86) a combination of 3 per cent homemade distillate-oil emulsion and nicotine sulphate (40 per cent), at the rate of 1 pint of the latter to 200 gallons of the former, is successfully used. The distillate-oil emulsion can be prepared by the fruit grower, provided he is equipped with a good power spraying outfit and follows the directions given herewith.

The process of making the emulsion consists of two operations: (1) Making the soap[1] and (2) mixing the soap with the oil.

Directions for making the soap.—The fruit grower should purchase nothing but unadulterated fish oil. Fish oils mixed with mineral or vegetable oils are not satisfactory. To make 40 pounds of fish-oil soap, use the following formula:[2]

Water	gallons	6
Lye (98 per cent)	pounds	2
Fish oil (pure)	gallons	1½

Place the water in a suitable vessel and start the fire. Add the lye, and when it is dissolved and the water is boiling pour in the fish oil. Stir now and then, and boil slowly for two hours. When the soap has been boiled sufficiently, it will give a ropy effect when stirred.

Directions for making the emulsion.—The distillate oil should be the untreated raw distillate, testing 30° to 34° Baumé and having a comparatively high flashing point. The ordinary stove distillates are not satisfactory, as they usually contain too much light gaseous oil. To make a 55 per cent oil stock solution, use the following formula or any convenient multiple thereof:

Boiling water	gallons	12
Fish-oil soap	pounds	30
Distillate oil (raw), 30° to 34° Baumé	gallons	20

[1] Commercial fish-oil soap may be used if desired.

[2] Foster, S. W., and Jones, P. R. How to control the pear thrips. U. S. Dept. Agr. Bur. Ent. Cir. 131. 1911.

Pour the boiling water into the spray tank and add the soap immediately while the agitator is running. As soon as the soap is thoroughly dissolved pour in the oil slowly, continuing the agitation. After the oil has been allowed to mix thoroughly pump the material, under a pressure of at least 175 pounds, through relatively fine nozzles into clean storage receptacles.

Directions for use.—In order to dilute the stock emulsion to a 3 per cent oil for thrips spraying, use $2\frac{3}{4}$ gallons, with water sufficient to make a total of 50 gallons, or 11 gallons of stock emulsion to a 200-gallon spray tank.

First start the agitator and pour the required amount of the emulsion into the spray tank and then add the water, keeping the agitator running. The nicotine should not be added until the oil emulsion has been diluted. As previously stated, use 1 pint of nicotine to each 200 gallons of 3 per cent oil emulsion.

MECHANICAL MIXTURE OF OIL AND WATER.

Several years ago sprayers were designed for mixing with water any desired percentage of kerosene or crude petroleum as it was being sprayed on the trees. These pumps, however, did not control the percentage of oil accurately, and injury to the trees frequently resulted, or ineffective work in the control of scale insects for which the spray principally was used.

A mechanical mixture of 6 per cent distillate oil and water made in a power spraying outfit has been used to a limited extent in California as a dormant spray for the European pear scale, moss, lichens, etc. The following formula has been principally employed:

Caustic soda	pounds	4 to 5
Distillate oil (raw), 30° to 34° Baumé	gallons	12
Water	do	188

Pour the water into the spray tank, start the agitator, and then add the lye. When this is dissolved, slowly pour in the oil, and after thorough agitation for a few minutes commence spraying. If desired the lye may be dissolved in a little hot water and poured into the spray tank in solution. In the use of this formula it is very essential that the sprayer be supplied with a good agitator, and that this be working continuously during the operation of spraying.

MISCIBLE OILS.

Proprietary "miscible" or "soluble" oils are more or less used as a dormant treatment for the destruction of the San Jose and many other scale insects, as well as the eggs of the fruit-tree leaf-roller,[1] etc. They are composed chiefly of a mineral oil emulsified with a soap usually made from a vegetable oil and an alkali. In a miscible oil the mineral oil is subdivided into many minute globules, and, when

[1] *Archips argyrospila* Walker.

mixed with water, the oil is evenly distributed throughout the water. The safe use of the miscible oils is thought to be largely dependent upon the relative fineness of the particles.

Manufacturers have placed on the market several brands of miscible oil. These vary somewhat in composition, but give practically the same results.

The use of miscible oil is sometimes attended with distinct injury, especially when the proper precautions are not observed. But under favorable conditions well-made miscible oils should not damage hardy fruit trees and are effective against the insects previously mentioned. Miscible oils are particularly valuable for use on large trees heavily encrusted with the San Jose scale, since the oils spread more readily than lime-sulphur solutions. Miscible oil is less disagreeable to apply than lime-sulphur and for this reason is preferred by some growers.

It should be remembered that miscible oil is for use primarily as a dormant spray, that it should be well stirred before using, that the spray tank should be free from alkalies and acids, that it should not be mixed with hard water, and that it should be poured into the spray tank first and the water for dilution added to the oil. The miscible oil should be applied in the *spring* while the trees are still dormant, and preferably during warm sunny weather. As in the case of all mineral-oil sprays, never allow the liquid to puddle around the base of the trees. The commercial preparations are usually used at the rate of 1 gallon diluted with 10 to 20 gallons of water. For the proper dilution and application, the fruit grower should follow carefully the directions given by the manufacturer.

HOMEMADE MISCIBLE OIL.

The commercial miscible oil is a relatively expensive dormant spray material, but miscible oil may be made at home by the fruit grower at a more reasonable cost. Unless the fruit grower has use for a quantity of miscible oil sufficient to warrant him in buying the raw materials in wholesale lots, however, it will not pay him to make it. In order to prepare a satisfactory miscible oil[1] it will be necessary to give careful attention to the details recorded herewith and to use the following ingredients of the grade and proportions specified:

Carbolic acid.[2]—This is sold at various strengths, but nothing under 100 per cent liquid crude should be used. This comes in two colors, "straw" and "dark," the latter being the cheaper and as satisfactory as the "straw."

[1] Jarvis, C. D. Proprietary and homemade miscible oils for the control of the San Jose scale. Conn. (Storrs) Agr. Exp. Sta. Bul. 54. 1908.

[2] Crude cresylic acid.

Fish oil.—Use pure fish oil, since oils adulterated with mineral oil or other materials are unsatisfactory. Menhaden oil fulfills the requirements and is a fairly cheap fish oil.

Caustic potash.—Commercial caustic potash is frequently sold in the stick or coarse lump form. If either of these is used, the caustic must first be dissolved in its own weight of hot water. The best caustic potash for the use of the fruit grower is the granulated, or ground material (90 per cent strength or over). This may be used without first dissolving it.

Kerosene.—Any standard kerosene (coal oil, lamp oil) can be used.

Paraffin oil.—This is a heavy fractional distillate of crude petroleum. A paraffin oil testing about 28° Baumé is one of the cheapest grades and is entirely suitable for the preparation of the miscible oil.

Rosin oil.—Rosin is a heavy vegetable oil produced as a by-product in the manufacture of turpentine. This is made in several grades, the cheapest of which is as desirable as the more expensive.

EQUIPMENT.

The equipment needed is very simple, consisting of a thermometer and cooking kettle. The thermometer should register 350° F. and its scale should be inclosed within the glass. Any iron pot of sufficient size may be used, but a cooking outfit such as that adapted to the making of lime-sulphur solution (fig. 3) is more desirable. The cooking vessel should be provided with a cover of wood or other material. There should be a small opening in the cover through which the thermometer may be lowered in order to get the temperature of the cooking liquid.

PROCESS OF MAKING MISCIBLE OIL.

The process of making the miscible oil may be divided into two distinct operations: (1) Making a soap solution, which is called the emulsifier; (2) mixing the emulsifier with the oils which are thereby rendered miscible, i. e., the product so formed will mix with water. The mixture of the miscible oil with the water for spraying purposes is known as an oil emulsion.

Preparation of the emulsifier.—The formula for the emulsifier is as follows:

Fish oil (menhaden)	gallons	10
Carbolic acid [1] (dark liquid crude, 100 per cent)	do	8
Caustic potash (commercial ground 90 per cent or over)	pounds	16
Heat to 290° to 300° F., then add—		
Kerosene	gallons	14
Water	do	20

[1] Crude cresylic acid.

The amounts given in the foregoing formula may be increased or decreased proportionately to suit the convenience of the fruit grower.

The preparation of the emulsifier should be carried on in the open, so that the fumes from the carbolic acid may not be confined and to avoid danger of fire. Care should be exercised to prevent the flames from reaching the top of the cooking vessel, since the mixture is inflammable when hot.

Pour the carbolic acid, fish oil, and potash into the cooking kettle. The kettle should not be over half full, since the contents when heated will foam, and for this action space must be provided. Start the fire and stir the mixture until the potash is dissolved and then place the cover on the kettle. The thermometer should be lowered into the material from time to time in order to ascertain the temperature. The material will begin to foam at about 260° F. When 280° F. is reached check the fire, and when the temperature rises to 290° to 300° extinguish the fire or remove the kettle. Next pour in the kerosene and stir. Finally add the water and stir thoroughly. Do not add the water until the mixture has cooled to 212° F. (boiling point of water) or below, since if this were done when the temperature was above 212° the steam that would be generated would be likely to cause an explosion. If the emulsifier is well made it will not deteriorate readily and may be kept for several seasons.

Preparation of the miscible oil.—After the emulsifier has been prepared it should be mixed with the paraffin and rosin oils in the proportions given in the following formula:

Emulsifier (soap solution)	parts	8
Paraffin oil	do	35
Rosin oil	do	5
Water	part	[1] 1

This formula is for paraffin oil and rosin oil, but the emulsifier may be used to make a number of other oils miscible, such as kerosene, crude petroleum, etc. In each case, however, a different formula will be required. The miscible oil can be made in clean barrels or other receptacles that are free from acids and alkalies.

Stir the emulsifier thoroughly, pour the foregoing ingredients, in the order named, into the container, and agitate briskly. No external heat is needed, but the materials should not be too cold. If they have a temperature of 60° to 70° F. they can be mixed readily. Continue stirring until a smooth creamlike condition is obtained. An easy method of mixing is to place the ingredients in a spray tank and pump the materials through the pump and back into the tank until the emulsion is complete. To test the product, pour a few drops into a glass of water. A white or milklike emulsion should result if the miscible oil has been made properly.

[1] More if necessary.

With a carefully prepared emulsifier and a good grade of paraffin oil it is sometimes possible to use as many as 45 parts of paraffin oil. It is good economy to use as much of the paraffin oil as can be properly emulsified, since this is the cheapest ingredient. To determine the maximum amount of paraffin oil that can be incorporated, small quantities of the ingredients should be mixed experimentally.

Directions for use.—For dormant spraying the homemade miscible oil should be used at the rate of 3 to 3½ gallons diluted with water to make a total of 50 gallons. Stir the miscible oil well and pour the required amount into the spray tank. Start the agitator and then add the water.

CREOSOTE-OIL EMULSION[1] (DORMANT TREE SPRAY).

Creosote-oil emulsion is used occasionally as a dormant spray for the treatment of certain scale insects and lichens on fruit trees. This emulsion, however, is not as effective as the distillate or the crude-oil emulsions and may cause injury. A 10 per cent creosote-oil emulsion (after dilution) may be made according to the following formula:

Boiling water	gallons	5, or	gallon	½
Caustic soda	pounds	2, or	ounces	3.2
Fish-oil soap	do	2	do	3.2
Creosote oil	gallons	5, or	gallon	½

First dissolve the caustic soda in the required amount of water, then the soap, and finally add the creosote oil. The mixture should then be forced through a spray pump until it is thoroughly emulsified. When ready to spray, add 40 gallons of water to the first, and 4 gallons of water to the second formula.

CARBOLIC-ACID EMULSION (FOLIAGE SPRAY).

Carbolic-acid emulsion has been recommended by some investigators as a foliage spray for the destruction of certain aphids, soft scales, and like insects. It is made according to the following formula:[2]

Fish-oil soap	pounds	40, or	pounds	4
Crude carbolic acid	gallons	5, or	gallon	½
Water	do	40, or	gallons	4

Place the water and soap (cut into small pieces) into a suitable container and bring to the boiling point. As soon as the soap is

[1] Geo. P. Gray, in California Agricultural Experiment Station Bulletin 269, states that crude cresylic acid is a more appropriate term than crude carbolic acid, and that crude carbolic acid, coal-tar creosote, and creosote oil are practically synonymous as commercially used in the United States. In some cases, however, there seems to be this distinction: The crude carbolic acid may have been derived from a certain fraction resulting from the distillation of coal tar which is lighter than water and therefore may contain a greater proportion of the lighter oils than the creosote oils which may have been obtained from the fractions which are heavier than water.

[2] Essig, E. O. Injurious and beneficial insects of California. Cal. Mo. Bul. State Com. Hort., v. 2, nos. 1 and 2. 1913.

dissolved and the liquid is boiling, add the carbolic acid and continue boiling for 20 minutes. A large cooking vessel should be provided to prevent the contents from boiling over. For spraying purposes this stock solution is to be used at the rate of 1 part diluted with 20 parts of water.

SOAP SPRAYS.

Sprays made from several kinds of soap are much used for the destruction of various soft-bodied sucking insects, particularly aphids, the pear psylla, certain plant-bugs, etc. Soaps are extensively used for making oil emulsions, and are also frequently combined with other spray materials to cause them to spread and adhere better to the foliage.

COMMERCIAL FISH-OIL SOAPS.

The commercial fish-oil soap, formerly known under the trade name of "whale-oil soap," is usually made from fish oils combined with either caustic soda or potash and should contain not over 30 per cent of water. An average grade of a soda fish-oil soap should contain, in addition to the water, about 10 per cent of caustic soda, 58 per cent of fatty matter as anhydrides, and about 2 per cent of other matter. Soda fish-oil soap is generally of medium to hard consistency, whereas the potash soaps are much softer. They are brownish in color, with a distinct fishy odor.

For foliage sprays the fish-oil soap is dissolved at the rate of 1 pound in 3 to 4 gallons of water or at greater dilutions, depending upon the insects to be treated and the hardiness of the foliage. For the dormant treatment of scale insects the soap is used at the rate of 2 pounds for each gallon of water and should be applied while hot. Soda soaps, especially when used at this rate, are likely to solidify upon cooling and clog the spraying apparatus. Soda soaps are fairly hard and usually require slicing and dissolving in hot water.

Fish-oil soaps may be used with the following spray materials to increase their spreading and adhesive qualities: Arsenate of lead, nicotine solutions, Bordeaux mixture, and sulphur. *Do not use soap in lime-sulphur solutions, or in waters strongly alkaline.*

HOMEMADE FISH-OIL SOAP.

Fish-oil soap may be prepared at home according to several formulas, with or without heat. The fish-oil soap used in making distillate-oil emulsion is made as follows:

Water	gallons..	6
Lye (98 per cent)	pounds..	2
Fish oil	gallons..	1½

Place the water in a cooking vessel and add the lye; as soon as the lye is dissolved and the water is boiling, pour in the oil and boil for two hours with occasional stirrings. When the soap has been

boiled sufficiently it should have a ropy consistency when stirred. About 40 pounds of moderately firm soap is produced by this formula. A good fish-oil soap [1] may be made at ordinary summer temperatures without the aid of external heat according to the formula given below:

Caustic soda	pounds..	6
Water	gallon..	½
Fish oil	gallons..	3¼

Thoroughly dissolve the caustic soda in the required amount of water. Then, while stirring constantly, add the fish oil very slowly and continue active stirring for about 20 minutes or until the soap is complete. The homemade fish-oil soaps may be used in about the same proportions as the commercial products.

LIQUID FISH-OIL SOAP.

Commercial liquid fish-oil soap may be substituted for the harder fish-oil soaps. Apply according to the directions given for fish-oil soap, using 1 pint of the liquid soap in place of 1 pound of the hard soap. Liquid soaps are especially convenient in making oil emulsions.

TOBACCO FISH-OIL SOAP.

Commercial fish-oil soaps containing a small percentage of nicotine are sold for insecticidal purposes. Soaps of this kind are somewhat expensive and their use is scarcely justified unless the nicotine is present in sufficient quantity to have distinct insecticidal value, namely, 0.05 to 0.06 per cent in the completed spray.

QUASSIA AND FISH-OIL SOAP.

Quassia extracts are used for destroying certain sucking insects, especially the plum or hop aphis. Solutions containing quassiin are more effective when combined with soap, which serves as a spreader and "sticker." Various formulas with different amounts of quassia chips and soap have been used, depending upon the insects to be destroyed. The following formula gives a fairly strong spray solution:

Quassia chips	pounds..	2½, or	pound..	¼
Fish-oil soap	do....	5 , or	do....	½
Water	gallons..	50 , or	gallons..	5

First dissolve the soap in a little hot water and pour into the container and then add sufficient water to make the total product equal to that given in the formula. Place the quassia chips (small chips are best) in cloth sacks and submerge in the soapy liquid for 24 hours. The soap aids in extracting the quassiin. Instead of soaking the chips as above, they may be boiled in the same amount of soapy water for 4 to 5 hours. In order to extract a large percentage of the quassiin the full amount of the water indicated in the formulas

[1] Van Slyke, L. L., and Urner, F. A. N. Y. Agr. Exp. Sta. (Geneva) Bul. 257. 1904.

should be used. Fruit growers will find no particular advantage in using quassia chips over nicotine solutions or kerosene emulsion. Quassia chips are not readily obtainable and the homemade extract, owing to its somewhat variable strength, is not always dependable.

RESIN FISH-OIL SOAP.

Commercial resin (rosin) fish-oil soaps are often used at the rate of 2 to 3 pounds to 50 gallons of spray to increase the adhesiveness of the spray material, especially on plums, grapes, and cranberries. They may be employed with arsenate of lead, Bordeaux mixture, and nicotine solutions with satisfactory results. When applied alone as a soap spray, they should be used at about the same rate as fish-oil soaps. An average grade of resin fish-oil soap contains about 66 per cent of fatty and resin anhydrides, 6 per cent of caustic soda, 26 per cent of water, and about 2 per cent of other matter.

HOMEMADE RESIN FISH-OIL SOAP.

Resin (rosin) fish-oil soap may be made at home according to the following formula:[1]

Pulverized resin (rosin)	pounds	5
Concentrated lye	pound	1
Fish oil	pint	1
Water to make total product	gallons	5

Place in a suitable cooking vessel the resin, oil, and 1 gallon of water, and heat. In the meantime dissolve the lye in a little hot water and after the resin has softened carefully pour in the lye solution. Thoroughly stir the mixture and then add 4 gallons of hot water and boil for about two hours, or until the resin soap will unite readily with cold water, making an amber-colored liquid. The total product should be 5 gallons and any water lost through evaporation should be made up with the necessary amount of additional water.

Use 2 to 3 gallons of the resin-soap "sticker" to 50 gallons of spray.

LAUNDRY SOAP.

In the absence of fish-oil soaps, ordinary laundry soap often may be used effectively where only a few plants are to be treated. An average laundry soap should be employed on plants in foliage at the rate of 1 pound to from 2 to 4 gallons of water, according to the kind of soap and the insects to be treated.

BORDEAUX MIXTURE.[2]

Bordeaux mixture, although essentially a fungicide, is sometimes recommended as a repellent to insects. The formula for making quantities of 50 gallons and of 5 gallons is inserted here, since Bor-

[1] Sirrine, F. A. A spraying mixture for cauliflower and cabbage worms. N. Y. Agr. Exp. Sta. (Geneva) Bul. 144. 1898.

[2] Formula and directions for making furnished by the Bureau of Plant Industry.

deaux mixture is several times referred to in the spraying schedules for apple and grape for the combined treatment of diseases and insects:

Copper sulphate (bluestone)	pounds	4, or	pound	½
Fresh stone lime	do	4, or	do	½
Water	gallons	50, or	gallons	5

Directions for making.—To make Bordeaux mixture for use in an ordinary barrel sprayer, dissolve the bluestone in 25 gallons of water and in a separate container, slake the stone lime, and dilute with water to 25 gallons. The two solutions then should be poured simultaneously through a strainer into the spray tank. Stock solutions, especially where large quantities are to be used, are desirable, since they save time. A stock solution of bluestone is made by dissolving it at the rate of 1 pound to 1 gallon of water. The bluestone should be suspended in a sack in the upper part of the barrel, or other container, so that it is just beneath the surface of the water. It will be dissolved if left for a few hours in cold water and more rapidly in hot water. A stock solution of lime may be made by slaking the lime in a little water and then diluting so that each gallon of water contains 1 pound of lime. Just before the stock solutions are used they should be stirred thoroughly. To make up 50 gallons of Bordeaux mixture from stock solutions it is only necessary for 4 gallons of the stock solution of bluestone to be poured into a suitable container, and 4 gallons of the stock solution of lime into a separate container, diluting each to 25 gallons, then pouring them simultaneously into the spray tank.

Commercial Bordeaux may be used in place of the homemade product.

For early summer spraying the amount of bluestone may be reduced to 3 pounds to lessen the risk of injury. Bordeaux mixture for grape spraying is made up of 4 pounds of bluestone and 3 pounds of stone lime to 50 gallons of water.

BORDEAUX MIXING PLANTS.

When using Bordeaux mixture in large quantities much time will be saved if a mixing plant (fig. 7) is employed. This should be provided with an ample water supply and should be sufficiently elevated so that the solutions will flow by gravity into the spray tank. A satisfactory arrangement for spraying outfits having a capacity of 200 gallons is to erect on the upper platform a large water supply tank (about 600 gallons) connected by pipes with two dilution tanks of 100 gallons each placed on the lower platform. The latter, in turn, should be connected by 3 to 4 inch pipes with a flexible hose through which the Bordeaux mixture may be conducted into the spray tank. Alongside of each dilution tank should

FIG. 7.—Bordeaux mixing plant.

be placed a 50-gallon barrel—one for the stock solution of bluestone and the other for the stock milk of lime. Each gallon of the stock solution should contain 1 pound of bluestone and 1 pound of lime. (See "Directions for making," p. 39.)

To make 200 gallons of Bordeaux mixture (4–4–50 formula) with a mixing plant of this type, dip out 16 gallons of the well-stirred stock milk of lime and pour into the lime dilution tank, and pour the same amount of the stock bluestone solution into the bluestone dilution tank. Then fill each of these up to the 100-gallon mark by running in water from the storage tank above. The stopcocks of the dilution tanks may then be opened so that the properly diluted lime and bluestone solutions will come together in the discharge tube and thence into the spray tank, the opening into which should be covered by a brass strainer.

TOBACCO OR NICOTINE INSECTICIDES.

Nicotine in solution obtained from tobacco has long been recognized as an effective agent for the destruction of many soft-bodied sucking insects, particularly aphids, pear and other thrips, pear psylla, etc. Nicotine solutions are especially valuable as contact sprays, since they can be applied at the required insecticidal strength without injury to the foliage. Moreover, nicotine extracts may be combined with many of the standard stomach poisons and fungicides without depreciating their value. These combination sprays are much used when it is desired to treat at one time certain sucking and biting insects and fungous diseases.

When tobacco or nicotine solutions are to be used alone, it is thought that their efficacy will be increased by the addition of 2 to 3 pounds of soap to 50 gallons of spray. The soap causes the spray to spread and adhere better.

COMMERCIAL NICOTINE SOLUTIONS.

Commercial nicotine, extracted from refuse tobacco, is sold on the market in several grades and strengths. A highly concentrated preparation, containing 40 per cent of nicotine sulphate, is at present being used extensively. The strength at which the commercial products are sold will not affect their insecticidal value if properly diluted. The diluted spray material should contain not less than 0.05 or 0.06 per cent of nicotine.

In orchard spraying 40 per cent nicotine sulphate is used at the rate of about three-fourths of a pint to 100 gallons of spray. For small spraying operations use about ¾ teaspoonful to a gallon, or 1 fluid ounce to 8 gallons of soapy water. (See dilution table, p. 75.)

HOMEMADE NICOTINE SPRAYS.

Tobacco decoctions may be prepared readily at home, and, although varying somewhat in strength, will give as satisfactory results as the commercial products unless used too weak. The practicability of making the nicotine sprays will depend chiefly upon the availability and cost of the refuse tobacco. Tobacco stems, sweepings, and damaged tobacco are the most economical for this purpose and the dark types of tobacco, owing to their relatively high nicotine content, are preferable to light-colored tobacco. If a desirable type of refuse tobacco can be purchased for $20 or less per ton, the fruit grower can make nicotine sprays at a cost of about 1 cent per gallon, exclusive of labor. The first cost of the tobacco waste is reduced by about one-half, since, after the nicotine has been extracted, the tobacco still has a fertilizer value of about $10 per ton.

The amount of refuse tobacco necessary to give a spray containing 0.05 or 0.06 per cent of nicotine will vary considerably, as will be noted in the following table (Table II) adapted from a publication of the Virginia Agricultural Experiment Station,[1] which is given as a guide:

TABLE II.—*Formula for making nicotine extracts.*

Kind of tobacco.	From—	Nicotine.	Number of pounds per 100 gallons necessary to make solutions containing different percentages of nicotine.	
		Per cent.	*0.06 p. ct.*	*0.05 p. ct.*
Light stems	Richmond, Va	0.481	145	121
Do	Danville, Va	.609	110	91
Sweepings	do	.884	74	62
N. L. Orinoco	Appomattox, Va	5.535	12¼	10¼
Olive	Powhatan, Va	3.367	19½	16¼
Light	Danville, Va	2.984	22	18
Sweepings	Louisville, Ky	.753	91	85
Smoker	Chatham, Va	2.306	28½	23½
Wrapper	do	3.05	21½	18
Cutter	do	3.466	19	15
Dark	Appomattox, Va	2.835	23½	19½
N. L. Orinoco	Bowling Green, Va	5.629	11½	10
Medium smoker	Chatham, Va	3.766	17½	14½
Common smoker	do	2.47	26	21½

[1] Ellett, W. B., and Grissom, J. Thomas. Preparation of nicotine extracts on the farm. Va. Agr. Exp. Sta. Bul. 208. 1914.

Since it is impracticable for the fruit grower to have the refuse tobacco chemically analyzed, he should approximate the class to which it belongs and use according to the foregoing table. The chief danger lies in making the solution too weak. If made stronger than necessary, no damage to the plant will result.

METHODS OF MAKING.

One of the most convenient as well as satisfactory methods of making nicotine sprays on the farm is by simply soaking the tobacco in the full quantity of water, with occasional stirrings, for a period of 24 hours. About 70 to 80 per cent of the nicotine will be extracted. After straining the tobacco solution to remove the particles of leaves and stems, it is ready for use.

The tobacco spray may also be made in a lime-sulphur plant equipped with steam. Place the proper amount of tobacco and water in the cooker and release the steam, and, as soon as the water reaches the boiling point, shut off the steam. As soon as the solution has cooled it is ready to use. By this method about the same percentage of nicotine is extracted as by the soaking process. The solution should never be boiled, as the nicotine is volatile.

Nicotine sprays should not be made up until they are to be used, since fermentation begins within two or three days, perhaps spoiling them for spraying purposes.

The homemade nicotine solutions, when prepared as above at the strengths indicated, will give control of most aphids. But as a matter of precaution it will be advisable to observe the effect of the spray upon the insects, and, if not effective, to strengthen it.

TOBACCO DUST.

Tobacco dust has long been recommended for the control of the woolly apple aphis on the roots of the apple, and for other root-inhabiting insects, and to a less extent for dusting low-growing plants, as currants and gooseberries for the destruction of aphids.

Tobacco dust has some value as a treatment for the woolly aphis on the roots of the apple, its effectiveness varying much with the amount of nicotine in the dust and its fineness and the character of the weather. Abundant moisture in the soil, as from irrigation or rains, leaches out the nicotine, thus destroying the insects to a greater or less extent. Where tobacco dust may be obtained cheaply its use is warranted for the woolly aphis, but the purchaser should insure himself that the dust is not the grade sold for fertilizer purposes from which the nicotine has been extracted. In addition to its insecticidal value, tobacco dust has a fertilizer value of approximately $10 per ton.

FUMIGATION OF NURSERY STOCK, BUDS, SCIONS, ETC.

Fumigation of trees from the nursery before planting and of buds, grafts, etc., for the destruction of scale insects, aphids, and other nursery pests is practiced by some orchardists and by nurserymen generally.

FUMIGATION BOXES.

When large quantities of nursery material are to be fumigated, as by nurserymen, specially constructed fumigation houses are used, while fumigation boxes of various sizes are employed for smaller operations, as by orchardists. These boxes, of any convenient size, as 6 by 3 by 2¾ feet, may be made of two thicknesses of lumber, such as plain matched ¾-inch ceiling, flooring boards, double matched sheathing, etc. Between the two layers of boards should be placed a double thickness of tarred paper. Near the bottom of the box should be placed a few cross pieces or slats, on which to lay the nursery material, allowing sufficient space beneath for the fumigation generator. The box should be strongly reinforced at the corners and at other necessary places, and on one side of the box a small door or opening which can be tightly closed should be provided for the admission of the generating receptacle and chemicals. In place of a complete fumigation box some growers use a box without a top, inverted bottom upward on the ground, the earth being packed tightly around the edges to prevent the escape of the gas. Whatever may be the type of box, it must be as nearly air-tight as possible and kept in that condition by necessary repairs. It will be well to give the box two coats of paint inside and out each year.

The most effective fumigant is hydrocyanic-acid gas. *This is extremely poisonous and if inhaled may prove fatal. Preferably it should be used by experienced operators and every precaution taken not to breathe any of the gas. Great care should also be taken to keep all chemicals accessible only to those using them, as the sodium cyanid is very poisonous and the sulphuric acid extremely caustic.*

Hydrocyanic-acid gas, if properly used, will not injure well-matured dormant nursery stock, nor will immature material, as buds, be damaged by effective quantities of the gas. The material to be fumigated should be reasonably dry and separated somewhat so that the gas may surround it thoroughly.

FUMIGATION SUPPLIES.

The following supplies are required and the chemicals should be of the grade as given below:

1. Sodium cyanid (96-98 per cent), containing 51 to 52 per cent of cyanogen.—When purchasing cyanid for fumigation purposes, this grade, which is known as "fumigation cyanid," should always be specified.

2. Sulphuric acid.—This should be a high-grade commercial product testing about 66° Baumé (1.84 specific gravity).

3. Generating vessel.—An earthen crock, china dish, or bowl may be used as a receptacle for the water and acid. *Do not use a tin or iron vessel of any kind, as the acid will corrode these metals.*

The formula to be used will depend upon the character of material to be fumigated, dormant trees and grafts being given a heavier dosage than buds.

FORMULAS.

Formula for dormant trees and grafts.

Sodium cyanid	ounce	1
Sulphuric acid	fluid ounces	1½
Water	do	2

For each 100 cubic feet of space inclosed, use the chemicals at the rate given above.

Formula for buds.

Sodium cyanid	ounce	½
Sulphuric acid	fluid ounce	¾
Water	do	1

For each 100 cubic feet of space inclosed, use the chemicals at the rate given above.

FUMIGATION PROCESS.

After the material to be fumigated has been placed in the house or box, and everything is in readiness, put the generator jar or jars in place and add the necessary water. Then pour the acid very slowly into the water. *Never pour the water into the acid,* as this procedure causes considerable heat and spattering of the acid. Next weigh out the cyanid and place it in a small paper sack and then gently drop it into the generator. *The operator must close the box or leave the house at once.* Where several generators are to be used, as in a large fumigatorium, the sacks of cyanid should be lowered into the generating vessels by means of strings operated at the door. By taking this precaution the operator will avoid any possibility of inhaling the deadly gas. The material should be fumigated for a period of 45 minutes to 1 hour.

In case of fumigating houses or large chambers, facilities for opening the doors and windows from the outside must be provided so as not to expose the operator to the fumes. No one should enter the fumigatorium until all the gas has been liberated by thorough ventilation.

DIPPING NURSERY STOCK, BUDS, SCIONS, ETC.

Some nurserymen and fruit growers dip nursery stock, scions, and bud sticks in order to insure as much as possible the destruction of any insects which may be present. The treatment is especially aimed at the San Jose and other scale insects and the woolly apple aphis on

apple. The principal dips are: Lime-sulphur concentrate (33° Baumé), 1 part to 7 parts of water (at temperatures of 60° to 120° F.); 20 per cent kerosene emulsion; or the miscible oils, 1 part diluted with 10 to 15 parts of water. The dipping method is not as effective as fumigation with hydrocyanic-acid gas (p. 43) and, further, may cause injury, depending upon the maturity and hardiness of the plants treated. The roots of nursery trees can not be dipped with safety in the lime-sulphur solution.[1] Entire trees, however, may be immersed in the oil emulsions with less likelihood of injurious results.

WORMING FRUIT TREES.

The most effective method of reducing injury to fruit trees by certain borers, as the peach and apple tree borers, is to "worm" the trees regularly in the spring and fall of each year. (Fig. 8.) Previous to worming, the earth should be removed from around the crown of the tree to a depth of 4 or 5 inches and the trunk brushed or scraped free of bark and loose dirt. With a little experience the worker can readily locate the borers in their burrows and remove them by means of a knife, stiff wire, or other suitable tool.

FIG. 8.—Large-scale worming of peach trees in Georgia orchard.

A combined scraping and gouging instrument is in use in the South and is reported to be a valuable tool in worming. A piece of steel bar or a suitable waste steel strip around the farm is flattened out along about two-thirds of its length into a dull blade two or three inches wide and gradually tapered to a point. The point is bent out and slightly upward to form a hook for gouging the insects in their burrows. The other end of the blade is fastened firmly into a 12 or 14 inch piece of wood for a handle, as a section cut from an old hoe or shovel handle. The whole tool is not more than 18 or 20 inches long.

In worming care should be taken not to cut the sound bark or wood more than necessary, and the cutting should be done vertically. Carelessness in the use of worming tools may result in more damage to the trees than would be caused by the insects. After

[1] Parrott, P. J., Hodgkiss, H. E., and Schoene, W. J. Dipping of nursery stock in the lime-sulphur wash. N. Y. Agr. Exp. Sta. (Geneva) Bul. 302. 1908.

trees have been wormed it is desirable, if practicable, to go over them again a few days later, when the location of any larvæ missed during the first examination will usually be indicated by the exuded frass. After the worming has been completed the earth should be replaced around the trees, and in the case of spring worming of peach trees it should be mounded around the base of the trunk to a height of 8 to 10 inches. (Fig. 9.) This will cause the borers to enter the bark somewhat higher and facilitate their detection and removal. If washes or wrappings are to be used, they should be put on at once after the spring worming and before the earth is replaced around the trees.

FIG. 9.—Application of whitewash and mounding of earth around peach-tree trunk against peach borer.

PROTECTIVE AND CAUSTIC WASHES FOR BORERS.

Washes of various materials have been recommended for use on fruit trees to repel adult insects from depositing their eggs or to prevent the entrance into the bark of newly hatched larvæ. These washes are to be applied after the spring worming, and before the adult insects have issued and begun to deposit eggs. Certain caustic washes have also been recommended for use at the time of fall worming, to destroy by contact any of the young larvæ that may have escaped the "hooking" and "worming" methods. As elsewhere stated (p. 45), reliance in borer control should be placed on worming, washes being used merely as an adjunct.

ASPHALTUM.[1]

Hard asphaltum (grades "C" and "D") has been recommended in California for use against the California peach borer, and it is claimed that this material is successful in preventing the issuance and

[1] Morris, Earl L. Pear thrips and peach tree borer. Cal. Agr. Exp. Sta. Bul. 228. 1912.

entrance of about 95 to 98 per cent of the insects, provided the application is thorough. It is reported not injurious to the tree, but it will be safer to try it on a few trees to ascertain its effect on them and its value under local conditions. The borers should be removed in the spring and fall, and the base of the tree, 5 to 6 inches below the ground level and the same distance above, painted with two coats of the asphaltum. It should first be heated and can then be readily applied with a brush.

GAS TAR.

Common gas tar, as obtained from gas works, applied in the spring after worming, has been used with some success, but in occasional instances damage to trees has been reported. It should not be employed until the trees are well established, by at least a year's growth and preferably longer. Gas tar is injurious to apple and probably also to other pome fruit trees. The heavier grades are preferred and, after warming, can be applied with a brush.

CARBOLIC ACID AND SOAP.

A wash consisting of a thick soap solution and carbolic acid has been more or less recommended, made up as follows:

Thick soap solution	gallons	10
Carbolic acid (commercial)	pint	1

Apply to lower trunk with brush in connection with spring worming.

LIME-CRUDE PETROLEUM.[1]

This mixture is made as follows:

Stone lime	pounds	50
Crude petroleum	gallons	6 to 8

Slake the lime with 10 to 15 gallons of hot water and while the lime is boiling slowly pour in the crude petroleum and stir thoroughly. Add sufficient water after slaking has ceased to make a thick paste. Apply immediately with a brush.

LIME, COAL TAR, FISH-OIL SOAP.

A wash consisting of lime, coal tar, and fish-oil soap may be made according to the following formula:

Stone lime	pounds	50
Coal tar	gallons	1½
Fish-oil soap	pounds	12

Slake the lime in hot water and stir in the coal tar while the lime is slaking vigorously. Dissolve the soap separately in hot water and add to the lime and tar mixture. Add sufficient water to make a heavy paste and apply with a brush.

[1] Moulton, Dudley. The California peach borer. U. S. Dept. Agr. Bur. Ent. Bul. 97, Part IV. 1911.

LIME-SULPHUR CONCENTRATE.

Lime-sulphur concentrates (33° Baumé), 1 part to 6 to 7 parts water, to which a large excess of lime has been added, is used by some as a deterrent to borers. It is reported as valuable in protecting trees from attack by mice and rabbits.

ARSENICALS IN BORER WASHES.

Arsenate of lead or Paris green is sometimes mixed with a wash with the idea of poisoning the larvæ which attempt to eat through it. Arsenicals in paints are used with considerable risk of injury to the trees.

PAINT.

Probably the best wash for apple-tree borers is a thick coat of paint, made from raw linseed oil and pure white lead. Remove the earth for a distance of 3 to 4 inches from the base of the tree, scrape off the dirt and loose bark scales, and, after worming, apply to the exposed trunk a thick, uniform coating of the paint to a distance of about 1 foot above the ground. Worming and painting should be done annually about early May, before the beginning of the egg laying season of the parent beetles. White lead paint has sometimes caused injury, probably on account of inferior ingredients

GOVERNMENT WHITEWASH.

A heavy whitewash, known as the "Government formula for whitewash," has been employed with more or less success on trees recently attacked by the shot-hole borer (p. 89). It is prepared as follows:

Stone lime	bushel	½
Salt	peck	1
Ground rice	pounds	3
Spanish whiting (plaster of Paris)	pound	½
Glue	do	1
Water	gallons	5

First slake the lime with warm water and then strain it through a fine sieve or strainer. Dissolve the salt in warm water, boil the rice flour to a thin paste, and dissolve the glue in boiling water. Mix the ingredients in the following order and stir well: Pour the salt solution into the lime, then the rice paste, and next stir in, boiling hot, the Spanish whiting and glue, and finally add 5 gallons of hot water. Stir thoroughly and let it stand for a few days. It should be applied hot with a brush.

Two formulas which have been used to some extent as cauterizing agents for the destruction of newly hatched peach-borer larvæ are given on page 49.

LIME, SULPHUR, AND GAS TAR.[1]

A wash made of a mixture of lime, sulphur, and gas tar has been employed in the South as a deterrent for spring use and as a caustic wash in the fall.

Stone lime	bushel	1
Sulphur (commercial ground)	pounds	10
Gas tar	gallon	½
Water	gallons	50

Slake the lime and add the sulphur during the course of the slaking. After the lime has been completely slaked, stir in the gas tar and then dilute with the requisite amount of water. For cauterizing purposes apply after fall worming.

LIME AND CAUSTIC SODA.

The lime-caustic soda wash may be readily prepared in accordance with the following formula:

Stone lime	pounds	70
Caustic soda	do	6
Water	gallons	50

Dissolve the caustic soda in hot water and when dissolved use this solution to start the lime slaking. Continue slaking the lime, adding more water as required, until it has completely slaked and then pour in enough water to make the total product 50 gallons. Apply in the fall at the time of worming.

COMMERCIAL PREPARATIONS.

Certain commercial sticky and other preparations are used against peach and apple tree borers, but apparently they possess no merit over the homemade washes or paints here described.

MECHANICAL TREE PROTECTORS.

Tree protectors of various materials and styles have been long recommended and are more or less used by orchardists. They are intended principally to protect peach, apple, and other fruit trees from attack by borers, mice, and rabbits. They are placed around the tree trunk and extend from a few inches below the surface of the ground to a foot or more above the ground level.

Heavy wrapping paper and tarred paper wrapped around the tree trunk and securely tied with strong twine have been used extensively, as well as wooden veneer protectors. Cylinders of wire screening are employed with the idea of preventing the adults of apple-tree borers from depositing their eggs on the lower part of the tree. Close-mesh wire fencing material is also used to keep away rabbits and mice.

[1] Starnes, Hugh N. The peach-tree borer. Ga. Exp. Sta. Bul. 73. 1906.

Repeated trials of various tree protectors have shown that they can not be depended upon to exclude borers to a satisfactory degree, though they are of value against rodents. Hence, if protectors are used and the trees are not regularly wormed, they are likely to become badly infested, the protectors frequently furnishing an ideal retreat for the insects.

A very large number of tree protectors have been patented, but none of these has shown sufficient merit to lead to its adoption to a general extent by orchardists.

BANDING FOR THE CODLING MOTH.

Banding the trunks and larger limbs of apple trees with strips of cloth has been practiced extensively for the control of the codling moth. Previous to the advent of spraying the banding method was the best means known of checking the ravages of this pest. This method consists in fastening a band of cloth around the trunk from which the loose bark has been removed. Usually a band made from burlap folded to three thicknesses 4 to 8 inches wide is used. The codling-moth larvæ, or worms, crawl beneath the band to form their cocoons and should be destroyed by hand at intervals of 10 days throughout the season.

Bands are still used as an adjunct to spraying in regions heavily infested with the codling moth. The use of the bands, although laborious and expensive, is profitable under these conditions, but if they can not be cared for systematically they should not be used.

A CODLING-MOTH BAND TRAP.

A codling-moth band trap (fig. 10) recently devised by the Bureau of Entomology can be substituted for the banding method. This trap, when properly adjusted to the tree trunk, permits the codling-moth worms to enter it and prevents the escape of the moths. While this trap was designed primarily for the codling moth, its principle is applicable to other insects having similar habits.

The trap can be readily made by the fruit grower at little expense, and may be attached at any time during the winter or spring, not later than one month after the petals have dropped.

SUPPLIES FOR MAKING AND ATTACHING.

The following supplies are needed for making and attaching the traps: (1) Black-painted wire-screen cloth 1 foot wide, 12 meshes to the inch; (2) burlap cloth; (3) pitch-tar; (4) small, portable oil heater; (5) hammer, pliers, wire shears, and tacks.

METHOD OF MAKING.

The wire screen is the ordinary fly screen, and the 1-foot width is the most desirable of the regular stock material to use. Cut the screen into strips 6 inches wide and fold over the edges twice, allowing one-

fourth inch to each fold. A convenient way to fold the edges is to use a folding machine as employed by tinners. If a crimping machine, such as used by tinners to reduce the ends of stovepipes, is at hand, both edges of the wire screen should then be run through the crimper. This will give the wire a very desirable bulge and at the same time will permit considerable expansion of the trunk without breaking the screen. Next cut the burlap into strips 6 inches wide and fold to three thicknesses. If the burlap after cutting is first soaked in water, it can be readily creased, and may then be done up in rolls for convenience in handling.

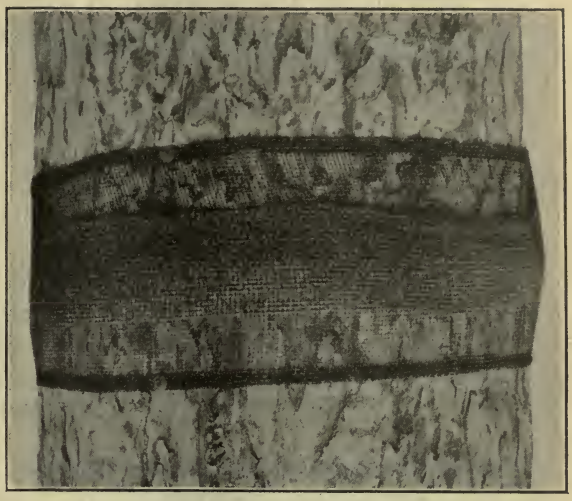

FIG. 10.—Wire-screen band trap for codling moth.

METHOD OF ATTACHING.

The traps may be fastened to the trunks by one person, but if many are to be attached, it will be better for two people to work together. After the loose bark has been removed from the crotches, lower limbs, and trunks, the traps may be put in place.

Select the most regular section of the trunk and encircle it with a strip of the burlap band. This is held in position by large tacks, the heads of which should project about one-fourth inch beyond the burlap or a total of about one-half inch from the trunk. These should be driven at intervals of 3 to 4 inches.

Next cover the band with the screen and tack one end, leaving the burlap in the middle of the screen. Let one person grasp the lower edge of the screen with the pliers and draw tightly while the other taps it with a hammer until it conforms snugly and, at the same time, fastens it to the trunk with tacks. Cut the wire screen long enough to allow an overlap of three to four inches. Proceed in the same way with the upper edge and finally tack the lap securely. It is advisable to fasten the lower edge first, since, if the upper edge is first attached, it is somewhat difficult to see whether the lower edge fits tightly. It will be noted that the tacks extending beyond the burlap serve to prevent the wire screen from pressing the band.

After the trap has been fastened, any openings along the edges of the screen or at the lap may be filled with pitch tar, which should be heated until it can be readily applied with a brush. On very irregular trunks, such as those having deep grooves, a trap extending part way around may be used, but this will not be as satisfactory as a trap completely encircling the trunk.

The success of the trap is dependent upon the edges being in close contact with the trunk, and, as long as there are no breaks, it will require no further attention.

HOW THE TRAP WORKS.

The principle of the trap is based upon the fact that the codling-moth worm can enter a smaller opening than that through which the moth can escape. When the worm completes its feeding within the fruit it leaves and searches for a secluded place in which to spin its cocoon. Usually it crawls up or down the tree trunk and, upon encountering the trap, enters through the wire screen. Once within the screen it hides beneath the burlap and spins its cocoon and later becomes a moth, which, owing to its size, is unable to escape. The moths are fragile and soon die and are frequently destroyed by other insects.

It must be clearly understood that the trap is not a substitute for spraying, but an adjunct. Despite the most thorough spraying, some worms will escape the poison, and the offspring of these are largely responsible for the damage to the fruit crop. By the use of the trap, in conjunction with careful spraying, the majority of the unpoisoned worms may be captured and injury by later broods thus greatly reduced.

DESTRUCTION OF INSECTS BY JARRING.

Certain insects, notably the plum and quince curculios (pp. 78, 87), may be much reduced in numbers by regularly jarring the trees in the early spring, collecting the insects on sheets or special cloth-covered frames. Jarring peach and plum trees was at one time the principal method of control of the curculio and was in vogue until rather recently. On stone fruits, however, jarring has now almost completely fallen into disuse in favor of spraying with arsenate of lead in self-boiled lime-sulphur mixture.

In the control of the quince curculio jarring is still practiced. The work is usually started early in the morning while the insects are sluggish and easily dislodged. A wheelbarrow umbrella catcher (fig. 11) is mostly employed, though the curculios may be collected on sheets placed on the ground or held beneath the trees. A smart rap with a padded wooden mallet serves to bring the beetles down. The

curculios upon falling feign death and are easily collected and destroyed by dropping in a can containing kerosene. In using the specially designed wheelbarrow umbrella catcher the tree is shaken by striking the trunk with a bumper on the framework of the wheelbarrow at the base of the slit in the umbrella, the beetles sliding by gravity to the center of the umbrella into a receptacle containing oil.

BAGGING FRUITS.

Choice fruits, especially grapes, may often be protected from insect pests by the use of paper bags placed around the bunches and securely fastened by twine to the supporting shoot or cane. This method is suitable for small vineyards and arbors in reducing injury from the grape-berry moth, the rose chafer, and the green June beetle, but it is too expensive for use on a commercial scale. Bags may be put in place as soon as the blossoms have fallen.

INSECT DESTRUCTION BY FIRE.

Gregarious insects, as the apple-tree tent caterpillar, fall webworm, and others, can be destroyed in their nests by means of a torch. A handful of rags fastened to a pole and soaked in kerosene will serve for this purpose. The nests should be burned while the caterpillars are at rest within, care being taken not to injure the larger limbs and branches. Egg masses of the gipsy moth and of other insects, deposited on stone walls and in similar situations, can be destroyed by burning with suitable blast or other torches. Cranberry bogs are sometimes burned over in order to destroy certain insects, such as the cranberry girdler. This is usually done by specially constructed torches. Leaves and trash in orchards, which frequently harbor injurious insects, should be well plowed under to add to the humus in the soil, or raked up and burned during the fall, winter, or early spring.

FIG. 11.—Wheelbarrow curculio catcher.

INSECT LIGHT TRAPS.

It is a well-known fact that certain insects are attracted at night to lights, and in an effort to take advantage of this habit insect light traps have been recommended at various times for the capture of injurious species. Some of the traps developed are very simple and others are more elaborate patented contrivances. The small forms consist of an ordinary lantern placed over a basin containing water which is covered by a thin film of kerosene or other oil. The insects in fluttering about the light fall into the oil and are destroyed.

FIG. 12.—Injury to apple tree resulting from injection under bark of cyanid mixture.

Careful experiments with light traps in orchards have demonstrated fully that these have only slight, if any, value in orchard-insect control. The light traps capture some injurious forms, but at the same time destroy a good many beneficial parasitic and predacious species. Many orchardists have been induced to purchase light traps which were guaranteed to capture the codling moth. This insect, however, is very little, if at all, attracted to light traps, and these are therefore useless in its control.

TREE INJECTIONS.

Claim is occasionally made, in circular matter issued by financially interested persons and in other ways, of the efficacy in insect and disease control of substances or compounds inserted into holes bored into trees or placed under the bark. Wonderful results have been claimed in some instances from such treatments, and some orchardists and numerous owners of a few yard trees have been induced to have their trees "inoculated." *The purpose of this paragraph is to advise fruit growers and others that such treatments are entirely without merit in controlling insects and diseases and are often decidedly injurious to the trees treated.* Figure 12 illustrates the injury to trees resulting from placing under the bark small quantities of a compound containing sodium cyanid, common salt, and certain other ingredients.

TREE-BANDING MATERIALS.

Bands of sticky material, 4 to 5 inches wide, applied around tree trunks sometimes may be used to advantage to prevent caterpillars, climbing cutworms, and certain other insects from climbing trees. These bands are also employed to prevent nonflying and wingless moths, such as the gipsy moth, cankerworm moths, tussock moths, etc., from ascending trees to deposit their eggs. Cotton batting and wire screen also are used in making protective bands.

The indiscriminate use of these bands, as well as mechanical barriers, is to be discouraged. Their use in parks is sometimes noted on trees which are not subject to attack by insects against which they would have value. As a rule, it is advisable to obtain advice as to their use from entomologists.

ROSIN-CASTOR OIL MIXTURE.

This may be made according to the following formula:

Rosin	pounds.. 5
Castor oil	pints.. 3

Place the rosin and castor oil in a pot and heat slowly until the rosin is melted. Add more oil if too thick.

These sticky bands are sometimes injurious to the tree, but injury may be avoided by spreading the adhesive on a strip of heavy paper encircling the tree trunk. A form of band that has given satisfactory results is made from cheap cotton batting and single-ply tarred building paper. The cotton should be cut into strips about 2 inches wide and wrapped around the tree trunk so as to fill all the crevices of the bark. Over the cotton is placed a strip of tarred paper about 5 inches wide, drawn tightly and securely tacked where it overlaps. The sticky material is then spread on top of the paper. (Fig. 13.)

FIG. 13.—Barrier of sticky material on tree trunk to prevent ascent of caterpillars, wingless moths, etc.

The sticky substance must be renewed from time to time, since when it dries out or becomes covered with dust or insects it fails as a barrier to crawling insects. If a combing instrument is occasionally drawn over the band it will serve to lengthen the usefulness of the band by bringing some of the sticky portion to the surface.

Sticky fly paper is used sometimes in place of the sticky bands.

This may be attached to the trunk by means of heavy twine tied tightly around the upper and lower edges, and properly should be put over a strip of cotton as described above.

NEW TREE-BANDING MATERIAL.[1]

The material described below, applied as a band around the trunk of trees, has been reported as a satisfactory barrier in preventing the ascent of caterpillars.

MATERIALS FOR MAKING.

The substances used for making this tree-banding material are: (1) Soft coal-tar pitch; (2) high-boiling neutral coal-tar oil (density about 1.15 at 68° F.); (3) rosin oil (first run "kidney" oil); and (4) stone lime.

METHOD OF MAKING.

The method of making may be divided into two parts:

Part I. Stock mixture.

Place a weighed amount of the coal-tar pitch in a suitable cooking vessel and heat until thin enough to run. Then add the neutral coal-tar oil, using twice as much by weight as of the coal-tar pitch, and stir thoroughly. The result should be a mixture which can be poured and worked after cooling.

Part II. Finished product.

a. Stock mixture ("pitch-neutral coal-tar oil")	pounds..	5
b. Neutral coal-tar oil	do....	16
c. Slaked lime[2]	do....	4
d. Rosin oil	do....	20
e. Neutral coal-tar oil	do....	10

Place materials *a*, *b*, and *c* in a mixing vessel and stir until of a uniform consistency. Next add the rosin oil and work in for 10 minutes, finally adding the additional 10 pounds of neutral coal-tar oil. Agitate the mixture thoroughly for 20 to 30 minutes and then transfer it to the storage container and allow it to stand two or three days, or until it becomes a semisolid cake. Then stir in 2 pounds of neutral coal-tar oil to each 50 pounds of the mixture in order to give it the desired oily surface. If too soft, add more rosin oil and lime; if too hard, use more neutral coal-tar oil.

This material should be applied on tarred paper strips over cotton bands, as elsewhere described (p. 55).

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[1] Burgess, A. F., and Griffin, E. L. A new tree-banding material for the control of the gypsy moth. Jour. Econ. Ent., v. 10, no. 1. 1917.

[2] The stone lime should be slaked to a dry powder by the addition of a little water and sieved through a creen of 10 to 12 meshes to the inch.

AXLE-GREASE, FISH-OIL, AND ROSIN BANDING MATERIAL.

A tree-banding material used in Europe, reported as effective, is made as follows:

Axle grease	pound..	1
Fish oil	pint..	1
Powdered rosin	pounds..	2

Heat the axle grease, to remove all of the water contained therein, in a cooking vessel having a capacity of at least 1 gallon. Then stir in the fish oil and finally the powdered rosin a little at a time. When the latter is dissolved, remove from the fire and the mixture is ready for use the next day. Apply to tarred paper bands as already described.

Several other sticky substances, homemade and proprietary, are used.

PRINTER'S INK.

Printer's ink usually consists of refuse ink and is sold as "tree ink," and should be mixed with a heavy oil to prevent its drying out too quickly. Apply as described for the new tree-banding material.

COTTON BATTING.

Barriers, other than sticky bands, are sometimes used to prevent insects from crawling up trees.

Bands of cotton batting about 6 to 8 inches wide are effective as long as the cotton remains fluffy. Wrap the band around the tree trunk and securely tie the bottom edge by means of stout twine. The upper edge should then be turned down over the string, forming a flange of loose cotton all around the tree. (Fig. 14.)

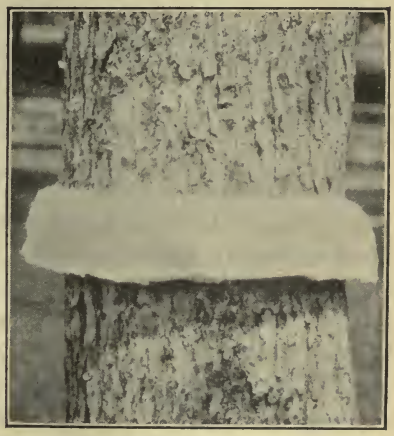

FIG. 14.—Barrier of cotton batting on tree trunk to prevent ascent of caterpillars, wingless moths, etc.

WIRE SCREEN.

Cankerworm moths, tussock moths, gipsy moths, and other non-flying moths may be prevented from crawling up the trees by a wire screen (ordinary fly screen, 12 meshes to the inch) tacked around the tree trunk. Cut the wire screen into strips 12 inches wide and sufficiently long to encircle the trunk. Tack the upper edge of the screen so that it fits snugly to the bark and allow the lower edge to extend out a distance of 1 to 2 inches from the trunk. The moths will crawl up into the screen trap and may be crushed daily by hand. This device, however, does not prevent the ascent of trees by any young larvæ hatched from eggs deposited by the captured moths below the barrier, and hence the sticky bands are more effective.

TREATMENT OF TREE WOUNDS.

Tree wounds due to removal of large limbs, or to injury from any cause, as by rabbits, field mice, plows, etc., around the base of trees, should be promptly disinfected and treated with a waterproof covering. An exposed surface is subject to attack by fungi and invasion by wood-boring insects unless properly cared for. As soon as a limb is cut off, the edge of the bark and the cambium should be coated at once with shellac, and unless this is done while the cut surface is still moist the value of the shellac is practically lost. The wound is then ready to be treated with a disinfectant, such as common creosote, which will penetrate and sterilize the wood. This may be applied with a small brush. After creosoting, the wood should be protected from moisture by means of a heavy coat of coal tar. Instead of using the materials separately, they may be combined in a mixture containing about one-third creosote and two-thirds coal tar. One coat of the mixed materials may be sufficient, but if not, a heavy application of the coal tar should be used, and the surface recoated whenever it is found cracking or breaking away from the wound. A pure white-lead and linseed-oil paint is sometimes employed for tree wounds, and, while not as satisfactory as the coal-tar-creosote paint, it is a good deal better than nothing. Ordinary grafting wax will give good results for small surfaces.

FILLING TREE CAVITIES.

Frequently decayed cavities in the trunk or limbs are infested with wood-boring larvæ or are the retreat of different species of ants. Such cavities are objectionable, for not only do they favor gradual decay and weakening of the trees, but they afford an excellent winter harbor for such insects as the codling moth. As noted elsewhere (p. 59), cavities in the trunk usually are the result of improper pruning and neglect to care for wounds from other causes. Such cavities may be filled with cement and the condition of the trees materially improved.

The first operation is to remove all of the decayed wood, and this can be done by means of a gouge, chisel, mallet, and knife. In cutting around the edge of the cavity nothing but very sharp tools should be employed, as dull instruments will injure the cambium. As soon as the cambium has been cut to a proper distance it should be covered with a coat of shellac. After the cavity has been thoroughly cleaned out it should be treated with creosote and coal tar, as described above, and it is then ready to receive the cement. Use a good grade of cement in the proportion of 1 part to 2 or 3 parts of clean sand. These materials should be mixed with water to a thick plastic consistency, and should be well tamped into the cavity.

PRUNING.

Certain twigs and branches of orchard trees, when heavily infested with or injured by insects, frequently can be removed in the course of pruning operations. Also, in the work of pruning, thought should always be given to maintaining the shape of the trees to facilitate the application of sprays.

In cases of severe insect injury, large trees sometimes should be severely cut back or "dehorned" in order to produce new healthy wood and in order that all parts of the trees may be better sprayed. With old trees, however, too much wood should not be removed at one time, and the dehorning process should be extended over two or three years. Small limbs and twigs incrusted with scale insects, or punctured by the periodical cicada, or tree-hoppers, etc., usually may be removed to advantage. Pruning should be done preferably before the application of dormant tree sprays, since it is a waste to use spray materials on limbs and branches that are to be removed later.

All dead trees and limbs should be promptly removed and burned, as wood-boring insects are attracted to them and may become abundant and attack and injure healthy trees. When limbs of trees are being removed, they should be sawed as closely to the trunk as possible to insure rapid and complete healing over. Stubs of limbs should not be left, as these decay, later resulting in a cavity which permanently injures the tree and will afford a hiding place for noxious insects. In cutting large limbs special care should be taken to prevent stripping of the bark from the trunk. A large limb is best removed by first sawing the limb from the underside at a distance of 6 or 8 inches from the trunk until the saw is pinched, by which time the cut should have reached from one-fourth to one-half through the limb. The second cut should be made on the upper side of the limb an inch or two farther from the base of the limb than the first one, sawing being continued until the limb falls. It is then easy to saw off the limb close to the tree trunk and in line with its woody surface, taking care, however, to support the stub until completely severed.

STIMULATION OF GROWTH BY FERTILIZATION.

Unthrifty trees and vines and other plants are thought to be more subject to the attack of certain insects than plants in a healthy condition. Weakened trees are frequently killed by wood-boring insects which do not attack trees growing vigorously. Such trees sometimes can be saved by prompt stimulation with a nitrogenous fertilizer, as nitrate of soda, stable manure, etc. This treatment, in connection with severe pruning and adequate cultivation, especially in the case of stone fruits, often will result in their marked improvement.

CULTIVATION.

Many fruit-insect pests which pass part of their life in the soil, such as the plum curculio, cankerworms, grape rootworm, etc., can be materially reduced in numbers by thorough cultivation, as is necessary in best orchard practice. When these insects are in the pupa stage in the soil they are very susceptible to injury, and thorough cultivation causes many of them to succumb.

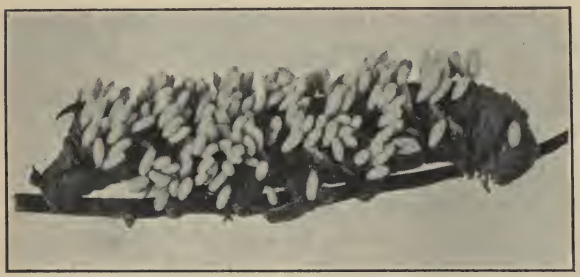

FIG. 15.—Sphinx caterpillar bearing cocoons of small, four-winged, wasplike parasite.

THINNING FRUIT.

In the course of thinning fruit, in order to insure larger size and better quality, much can be done to reduce the numbers of certain insect pests, as the codling moth and curculio, if the infested fruit be searched for and removed from the trees and promptly destroyed by feeding to hogs, or otherwise. Special care should also be given in thinning to remove as far as possible fruits showing blemishes of various kinds, as from injury by aphids, plant-bugs, etc., thus giving the sound fruit a better chance.

PARASITIC AND PREDACIOUS ENEMIES OF INSECTS.

Most species of noxious insects are subject to attack by one or more—usually several—parasites or predatory enemies, and these natural agencies are very important factors in their control. Entomologists have given much attention to the possibility of arraying one insect against another, and in numerous cases such efforts have met with pronounced success. In the case of most orchard insect pests, however, artificial means, such as spraying, must be relied upon for their subjugation, although the orchardist should encourage his insect and other friends as much as possible.

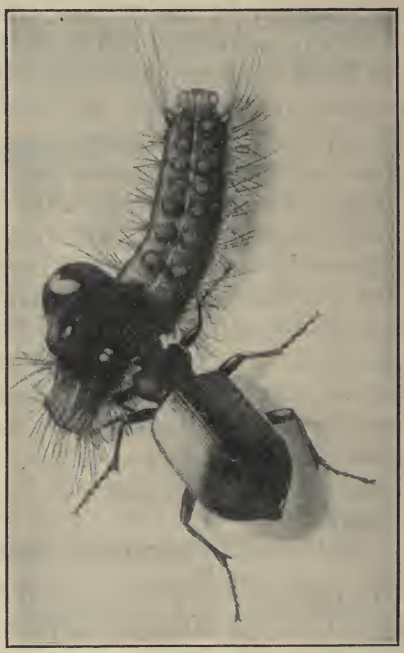

FIG. 16.—Caterpillar of gipsy moth (*Porthetria dispar*) attacked by the Calosoma beetle, *Calosoma sycophanta*. (Burgess and Collins.)

Owing to their diminutive size, parasitic insects, especially the little four-winged flies (see fig. 15), are not usually observed by the fruit grower. His predatory insect friends, however, as tiger beetles, ground beetles (fig. 16), lady-bird beetles, etc., are more evident.

Birds are among the more important natural checks to insect life, and certain species especially frequent orchards. Woodpeckers are well known for their ability to dig out insects, and certain species are valuable aids in the destruction of the codling moth and other insects concealed beneath the bark. Other insectivorous birds frequenting orchards are warblers, creepers, tit-mice, flycatchers, quails, doves, etc.

The common toad is an enemy of numerous insects. Approximately 98 per cent of its food is of animal origin and much over 60 per cent consists of injurious insects. The toad feeds during the

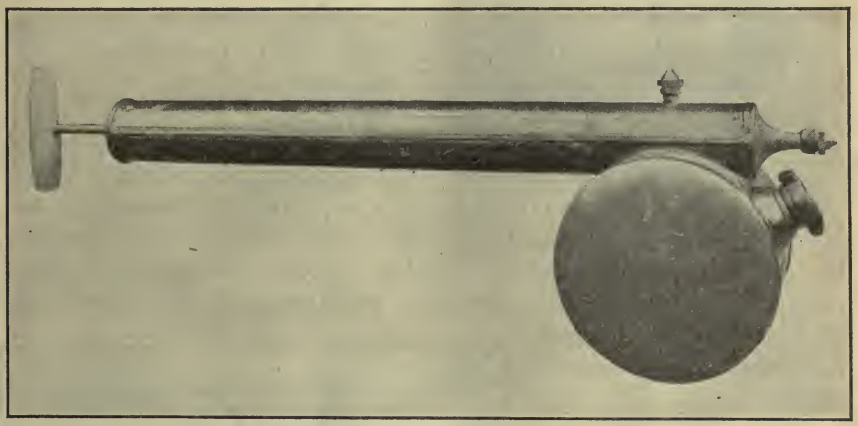

FIG. 17.—Hand atomizer, useful for spraying small plants.

evening and night and in 24 hours consumes an amount of insect food equal to about four times its stomach's capacity. Numerous important insects have been found in its stomach, as the plum and apple curculios, tent caterpillar, cankerworms, gipsy-moth caterpillars, and even the brown-tail moth caterpillars with their poisonous hairs.

Domestic animals sometimes may be utilized in insect control Hogs are useful in consuming fallen, infested fruit in orchards, though the trees are frequently damaged by them. Chickens and turkeys in orchards accomplish much good in the destruction of various insects on the ground, as curculios, certain caterpillars, and the like

SPRAYING OUTFITS FOR SMALL OPERATIONS.

HAND ATOMIZERS.

For spraying a few plants or very small trees hand atomizers may be used. These are made of brass, copper, heavy tin, or other material, and usually have a capacity of about 1 quart. (Fig. 17.)

FIG. 18.—Bucket pump, suitable for spraying a few plants and low-growing trees in home grounds.

BUCKET PUMPS.

Bucket pumps (fig. 18) are fairly convenient and satisfactory for spraying small gardens and shrubs or small trees. They should be of brass or other noncorrosive metal and preferably should be equipped with an agitator. In some pumps agitation is provided by means of a small jet of the liquid which squirts from the bottom of the pump into the liquid as the pump is operated. For convenience in spraying, these pumps may be clamped to the bucket, or used free in a tub or other vessel containing the spray material. They should be supplied with a spray rod, and sufficient hose to spray conveniently the plants to be treated.

KNAPSACK PUMPS.

A knapsack pump (fig. 19) may be used for small spraying operations. These pumps have a capacity of about 4 gallons and are provided with an air chamber to insure pressure and a steady spray. They are carried on the back of the operator and pumped by one hand, while the other is used to hold the spray rod.

SMALL COMPRESSED-AIR PUMPS.

Compressed-air pumps (fig. 20) are frequently used in small fruit gardens, and are preferred to the bucket or knapsack pumps by those who do not wish to pump while applying the spray. These pumps are usually made of brass or galvanized sheet steel and have a capacity of 3 to 4 gallons. They are carried by means of a shoulder strap. In the better types agitation

FIG. 19.—Knapsack pump, for spraying on a small scale; not now extensively used.

is provided, usually by the entrance of the air at the bottom of the tank. After the spray material is poured into the tank, and the opening closed by the tight-fitting cap, the air is pumped until the liquid is under pressure. The tank is usually emptied by three to four pumpings of a dozen strokes each.

FIG. 20.—Compressed-air sprayer for small spraying operations; no pumping is required while spraying.

BARREL PUMPS.

The barrel hand-pump outfit (fig. 21) has a capacity of about 50 gallons, and has come into extensive use for the home orchard or fruit garden. With a good barrel pump considerable spraying may be done in a satisfactory manner.

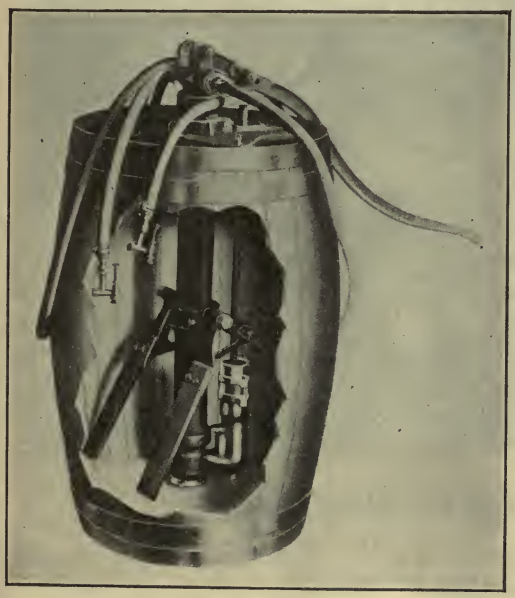

FIG. 21.—Barrel pump, suitable for spraying the fruit garden or home orchard.

The working parts of the pump should be of bronze, brass, or other noncorrosive material, and the valves and plungers should be readily accessible and easily repaired. The pump should be provided with an efficient agitator, either of the paddle or rotary type. To insure a good pressure and uniform discharge of the spray material the pump should be provided with an adequate air chamber, to which a pressure gauge may be attached if desired. The pump may be mounted either on the head or side of the barrel, and

the whole outfit placed on skids or on a wagon. On hilly land it is preferable to have the barrel in a horizontal position.

DOUBLE-ACTION HAND PUMPS

The double-action hand pumps (fig. 22) usually are employed in connection with spray tanks of greater capacity than a barrel, as the 150 or 200 gallon half-round tank used in place of the wagon bed. The pump, which may be either vertical or horizontal, is fastened to a small platform, and placed on top of the tank or on a platform at the hind end of the wagon. A suction hose extends into the spray

FIG. 22.—Double-action hand pump for spraying home orchard or small commercial orchard.

tank. A barrel or 100-gallon hogshead may be used, however, and placed at one end of the wagon bed or platform, thus leaving plenty of room for the pump and operator. When properly used these double-acting, double-cylinder pumps furnish adequate pressure for two leads of hose, and for single or double nozzles. They furnish an outfit intermediate in cost and capacity between the barrel pump and the gasoline or other power sprayer. A common defect is lack of adequate facilities for agitation, although tanks are available in which this deficiency is corrected to some extent.

SPRAYING OUTFITS FOR LARGE OPERATIONS.

Spraying outfits for commercial orchards and vineyards are generally operated by gasoline engines, although traction sprayers and compressed-air outfits also are in use.

TRACTION SPRAYERS.

In the traction type of sprayer (fig. 23) the pump is geared to or connected with the wheels and the pressure is generated while the

FIG. 23.—Traction sprayer, pump being geared to the wheels.

spray rig is moving. These sprayers are used in vineyards, but more especially for low-growing crops. The difficulty of providing for sufficient pump capacity and pressure is a serious objection to the traction type of sprayer for orchard and vineyard use.

FIG. 24.—Compressed-air sprayer, not much used except in orchards planted on steep, rough hillsides.

COMPRESSED-AIR SPRAYERS.

Compressed-air sprayers have been used more or less in orchard spraying but are much less popular than gasoline-power outfits. Compressed-air sprayers (fig. 24) are mounted low, and, owing to their small size and light weight, may sometimes be used to advantage on steep hillsides where the ordinary power sprayers are impracticable. The compressed-air outfit consists of two tanks, one for the air and the other for the

spray material. As the air is released into the spray tank, the spray material is forced out under a constantly decreasing pressure. The air tank is charged at a central pumping station by means of a compressed-air pump.

GASOLINE-POWER SPRAYERS.

Spray pumps, operated by gasoline engines, are by far the most useful type of sprayer and are made in various sizes and styles to suit almost any requirement. Special outfits have been designed for hillside spraying, vineyard spraying, shade-tree spraying, etc.

The smallest power sprayers are nothing more than an ordinary barrel pump equipped with a small engine of 1 to 1½ horsepower. These small mechanical outfits are higher in price than the hand pump, but are usually worth the additional first cost. They may be operated at a comparatively small cost and will give a steadier spray and at a higher pressure than will the pumps operated by hand. With the small power outfit one lead of hose is generally used, but two leads may be employed if the pump has sufficient capacity.

Large power sprayers (fig. 25 and title-page illustration) are made with pumps of from two to four cylinders, having a capacity of 5 to 15 or more gallons per minute under a pressure of 150 to 300 pounds. These sprayers are operated by gasoline engines of from 2 to 12 horse-

FIG. 25.—Gasoline-power spraying outfit with carpenter's horse type of tower and rotary pump tank filler.

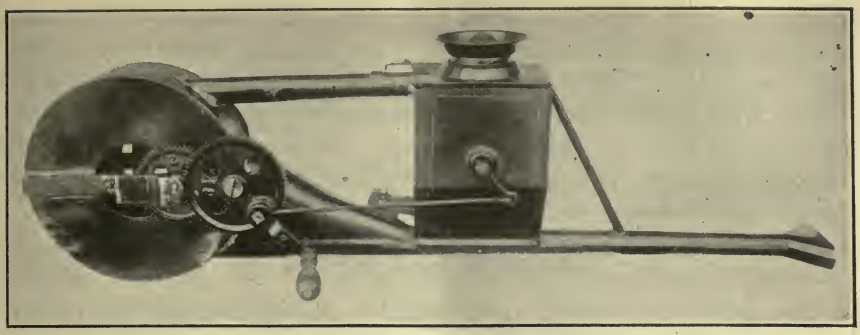

FIG. 26.—Hand duster for applying dust mixtures in the fruit garden.

power. For the four-cylinder pumps of large capacity, auto-type 4-cylinder engines of 10 to 12 horsepower are sometimes used.

The spraying outfits used by the majority of commercial orchardists consist of a 2 to 3 cylinder pump with a capacity of 6 to 9 gallons of spray material per minute, and able to furnish a pressure of 200 to 250 pounds. These outfits are equipped with gasoline engines of from 2 to 4 horsepower and usually are provided with a 200-gallon tank and good agitation.

The makes of spray machines now on the market vary a good deal in durability and efficiency. The fruit grower, before selecting an outfit, should consider carefully the several designs and choose an outfit that will best meet his requirements.

DUSTING APPARATUS.

Apparatus of various styles and adapted to a wide range of use for applying insecticidal dusts to plants is available on the market.

HAND DUSTERS.

There are several types of small dusters for treating low-growing plants, as currants, grapes, bush fruits, and even small fruit and other trees. In the bellows type the air blast is generated by a bellows; in the cylinder type a cylinder and piston rod are utilized to make the air blast. A larger hand duster (fig. 26), suitable for rather extensive dusting operations on low-growing plants, is furnished with a fan operated by cogs or a belt from a hand crank.

The large type of hand duster is usually mounted on a platform to be placed on a wagon or truck, and is suitable for the home orchard or small commercial orchard. Machines of this type, however, are rather difficult of operation and have not come into general use.

POWER DUSTING OUTFITS.

Power dusting outfits (fig. 27) are for use in large commercial orchards. The dusters are usually operated by a 2 or 3 horsepower

gasoline engine. The essential parts are the hopper, feeder, air chamber, fan, and discharge tube. The dust mixture is poured into the hopper, from which it is fed into the air chamber, where it is caught by a strong current of air generated by the rapidly revolving fan, and is forcibly expelled through the flexible discharge pipe. These outfits are provided with a clutch controlling lever and a device for regulating the amount of material discharged.

SPRAYING ACCESSORIES.

The spraying outfit is not complete or efficient unless properly equipped with useful accessories. Spraying devices that will save time or aid the fruit grower in doing more thorough work should be

FIG. 27.—Large dusting outfit for use in commercial orchards.

provided. The equipment need not necessarily be elaborate or expensive, but should be sufficiently complete and modern so that the orchardist will not be handicapped when the time to spray is at hand. Spraying, to be most effective, must be done at critical periods, and delays caused by insufficient or inferior equipment may mean a heavy monetary loss.

SPRAYING TOWER.

Large trees can not be properly sprayed without the aid of a tower that will enable the sprayman to reach the higher parts of the trees and to see where and how he is applying the spray material. The height and shape of the tower will depend upon the size of the trees and their distance between the rows. Square or oblong shaped towers, built over the spray tank, are most frequently used, but in orchards

where the trees are close together a tower erected on the order of a carpenter's horse (fig. 25) will serve the purpose better. With the latter form, a platform is built at a height to permit the operator to straddle the padded horse. The towers are usually constructed of wood, steel, or iron.

SPRAY NOZZLES.

Manufacturers of spraying machinery and accessories have placed on the market a large number of nozzles to which they have given various trade names. Although these nozzles differ somewhat in size and style, the principle of construction is not distinctive for each. The nozzles used by fruit growers may be roughly divided into two general types: (1) The Bordeaux, and (2) the eddy chamber or whirlpool type. This latter type is susceptible of further subdivision.

The Bordeaux nozzle (fig. 28) may be adjusted to give a relatively fine fan-shaped spray, or a coarse driving, or even a solid-stream spray, with all gradations between. Bordeaux nozzles do not easily clog and may be readily freed from coarse spray particles or other sediment by turning the barrel by means of the small handle on the side of the nozzle. These nozzles deliver a large amount of spray material, and in order to insure a satisfactory spray the pump must have ample capacity, and a high pressure must be maintained. The Bordeaux type of nozzle has been frequently recommended for the calyx application for the codling moth, to secure a coarse, driving spray. It is not as convenient to do orchard spray work with the Bordeaux nozzle as with the whirlpool or disk types, since the handle of the former frequently catches in twigs.

FIG. 28.—Bordeaux nozzle.

The whirlpool or cyclone type of nozzle is the most popular and useful for general orchard spraying. With this type the spray material enters an eddy chamber at a tangent, causing the liquid to whirl rapidly. The spray escapes through a small opening in the center of the top of the nozzle, producing a hollow cone-shaped spray. Some nozzles have been designed to produce a more or less solid cone-shaped spray.

The original whirlpool nozzle is commonly known as the Vermorel and, as now constructed, is provided with a degorger (fig. 29) for use in cleaning the nozzle when clogged. This nozzle gives a very fine misty spray with low pressure, and therefore can be used

to advantage with spray pumps of small pressure capacity. The Vermorel nozzle is made singly or in clusters of 2 (fig. 29), 3, and 4 nozzles. These clusters, like the Bordeaux nozzle, are often a source of annoyance in orchard spraying, since frequently they catch in the twigs.

FIG. 29.—Cluster of two Vermorel (eddy-chamber type) nozzles equipped with degorger.

The disk-whirlpool type (fig. 30) is extensively employed by commercial orchardists, and is well adapted for use with small spraying outfits. These nozzles are usually provided with three interchangeable disks or plates, each having a different sized opening to give a fine, medium, or coarse spray. In common with the Vermorel the spray material passes through a tangential opening into the eddy chamber where it obtains its whirling motion and escapes through the opening in the disk. The disk nozzles are relatively small and compact and, owing to the absence of any appendages, do not catch in the branches of trees. The coarse spray disks deliver a fairly large quantity of spray material, and can not be used satisfactorily with pumps of small pressure capacity. With the smaller spraying outfits the disks having small apertures should be used.

FIG. 30.—Large eddy-chamber or whirlpool-disk type of nozzle and elbow or crook.

Disk nozzles are usually made in two forms: (1) Straight (fig. 30) and (2) angled (fig. 31). The latter throws the spray at an angle to the spray rod, is convenient for most spray work, and is especially desirable for the calyx application for the codling moth. The straight nozzles can be attached to an elbow (fig. 30) or nozzle crook in order to obtain the same results.

NOZZLE Y.

For rapid spraying, with outfits having sufficient capacity and pressure, two nozzles per rod may be used. These can be attached to the spray rod by means of a Y. The Y's are made straight for angle nozzles or curved for straight nozzles.

FIG. 31.—Angled nozzle of the eddy-chamber or whirlpool-disk type.

SPRAY RODS.

Spray or extension rods (fig. 32) are employed in order to reach the upper and inner parts of the trees. These generally consist of an aluminum, brass, or iron rod contained within a bamboo pole and are usually made in lengths of from 6 to 14 feet. Some fruit growers use an ordinary gas pipe, but the lighter weight spray rods are much more desirable.

FIG. 32.—Bamboo spray rod.

ANGLE SHUT-OFF.

An angle shut-off, connecting the spray hose with the base of the spray rod, is a convenient device for cutting off the spray material whenever desired, as in passing from one tree to another. The angle construction permits the hose to hang in its natural position, and thereby saves the hose from wearing at the coupling. Without an angle shut-off, spray material is frequently wasted because of the inconvenience of closing the stopcock.

SPRAY HOSE.

Only the best-grade high-pressure hose, usually about $\frac{3}{8}$ to $\frac{1}{2}$ inch inside diameter, should be used for spraying operations. The length of the hose for the men spraying from the ground will vary according to conditions, but should be adequate for the work to be done. In commercial orchard spraying, from 25 to 50 feet, with an average of about 35 feet, of hose is desirable, and this will be long enough to permit the spray men to work around the tree without hindrance. The length of the hose for the tower will depend upon the height of the spray tower.

HOSE COUPLINGS AND CLAMPS.

It is poor economy to use lightweight hose couplings and clamps, since rough usage will soon cause them to break or blow out. Heavy couplings and clamps are obtainable, and these will give better satisfaction.

TANK FILLERS.

During spraying operations it is highly important to refill the spray tank quickly, since delays in filling waste the time of the team and spray men. Unless the commercial fruit grower is provided with a convenient water system, a tank filler is practically indispensable. This device, which usually operates on the jet system, will promptly fill the tank from any source of water, such as a cistern, pond, etc. Rotary pumps (fig. 25) connected with the spray engine are employed for the same purpose and are more satisfactory where the water contains considerable sediment. Rotary pumps are frequently used in the western fruit-growing districts where the water is drawn from the irrigation ditches.

FIG. 33.—Strainer for use in removing sediment in sprays when being poured into the spray tank.

PRESSURE REGULATOR.

This is a useful attachment for the regulation of the pressure. By its proper adjustment a uniform spray is obtained at the pressure desired.

MISCELLANEOUS SPRAYING SUPPLIES.

The following accessories should be provided:

Scales.—A good pair of scales should be used for weighing out the spray materials. Guesswork is poor economy.

Galvanized buckets.—These are useful for measuring liquid spray materials.

Strainer.—Before admitting spray material into the spray tank, it should first pass through a screen (fig. 33) to remove all of the coarse particles. The opening in the spray tank for filling purposes is usually provided with a removable brass screen.

Extra parts.—Extra parts of the equipment most subject to wear or breakage should always be on hand. Failure to observe this precaution will frequently result in delays at critical spraying periods.

Tools.—Tools specially made for the different parts of the spraying outfit are usually supplied by the manufacturer. Other standard tools, however, such as wrenches, screw drivers, hammers, etc., should be carried in the tool box in case of need.

STANDARD SPRAY MATERIALS AND THEIR COMBINATIONS FOR SUMMER SPRAYING.

Orchards and vineyards are usually troubled with different classes of pests, as biting insects, sucking insects, and fungous diseases, each of which usually requires for its control a different kind of spray

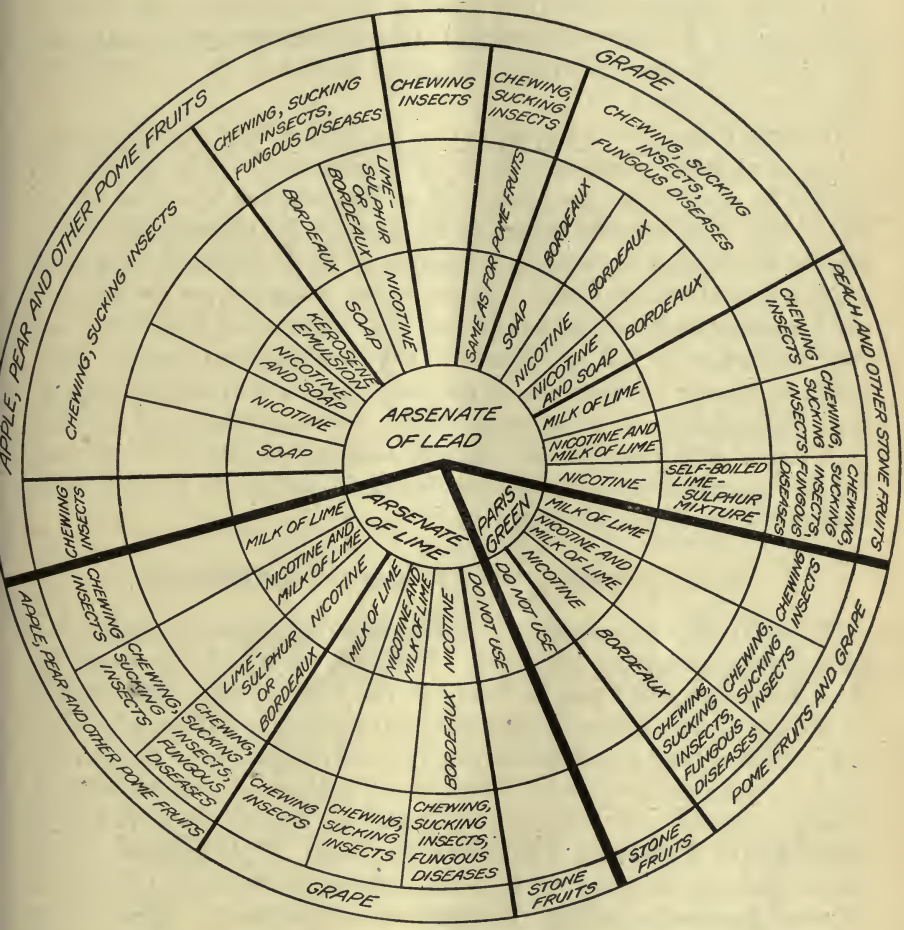

FIG. 34.—Showing what sprays may be combined and plants which may be treated.

material. Fortunately it is possible to combine the necessary materials for the simultaneous control of the pests, thus avoiding separate applications.

In figure 34 are given the standard spray materials for chewing insects, sucking insects, and fungous diseases and the way in which they may be combined. It will be noted that there are three main divisions separated according to the principal stomach poisons in use: (1) Arsenate of lead; (2) arsenate of lime, and (3) Paris green. Each

of these divisions is divided in accordance with the kind of fruit: Pome fruits, grape, and stone fruits. These, in turn, are subdivided into sections: (1) Chewing insects; (2) chewing and sucking insects; (3) chewing insects, sucking insects, and fungous diseases. These are further divided, when a choice of spray material could be given. To make use of the diagram, the first consideration is the kind of fruit to be sprayed; next, the pests to be combatted; and, finally, the choice of the spray materials. In selecting the spray materials the specific recommendations, as given elsewhere in this bulletin, should be consulted.

If pome fruits, for example, are to be treated for chewing insects, arsenate of lead, arsenate of lime, or Paris green may be used; but, as will be seen in the diagram, milk of lime should be added to the latter two. If stone fruits are to be sprayed for chewing insects, it will be noted that nothing but arsenate of lead combined with milk of lime should be employed. Again, suppose apple trees are infested with chewing and sucking insects and that arsenate of lead is selected for the former, it will be observed that this arsenical may be combined with soap, or nicotine, or nicotine and soap, or kerosene emulsion. If apples are to be sprayed for both chewing and sucking insects and also fungous diseases and arsenate of lime is to be used for the chewing insects, nicotine should be added to it, and lime-sulphur or Bordeaux mixture.

SPRAY DILUTION TABLE FOR READY REFERENCE.

Table III shows the amount of spray material required for a number of different quantities of spray. The rate at which the materials have been computed will be found in the first column. The figures at the top of the table represent the total number of gallons of diluted spray desired, and the figures in the vertical columns give the amount of spray material required. Thus, if 150 gallons of arsenate of lead, paste, at the rate of 2 pounds to 50 gallons, is to be used, it will be noted in the table that 6 pounds is required. If 25 gallons of self-boiled lime-sulphur mixture is needed, the table shows that 4 pounds of stone lime and 4 pounds of sulphur should be used. Again, if 100 gallons of kerosene emulsion, 10 per cent strength, is wanted and the stock solution contains 66 per cent of kerosene, it will be found by referring to the table that 15 gallons of the stock emulsion should be used.

TABLE III.—*Spray dilution table for ready reference. (A) For trees in foliage; (B) for dormant trees.*

	Total gallons of diluted spray material.									
	200	150	100	50	25	20	15	10	5	1
(A) SPRAY MATERIAL AND USUAL RATE OF DILUTION FOR TREES IN FOLIAGE.										
Stomach poisons.										
Arsenate of lead, paste, 2 lbs. to 50 gals	8 lbs	6 lbs	4 lbs	2 lbs	1 lb	12.8 oz	9.6 oz	6.4 oz	3.2 oz	0.64 oz. or 1 teaspoonful.
Arsenate of lead, powder, 1 lb. to 50 gals	4 lbs	3 lbs	2 lbs	1 lb	8 oz	6.4 oz	4.8 oz	3.2 oz	1.6 oz	0.32 oz. or 3 teaspoonfuls.
Arsenate of lime, paste, 2 lbs. to 50 gals	8 lbs	6 lbs	4 lbs	2 lbs	1 lb	12.8 oz	9.6 oz	6.4 oz	3.2 oz	0.64 oz. or 1.5 teaspoonfuls.
Arsenate of lime, powder, ¾ lb. to 50 gals	3 lbs	2.25 lbs	1.5 lbs	12 oz	6 oz	4.8 oz	3.6 oz	2.4 oz	1.2 oz	0.24 oz. or 2 teaspoonfuls.
Paris green, 6 oz. to 50 gals	1.5 lbs	1.12 lbs	12 oz	6 oz	3 oz	2.4 oz	1.8 oz	1.2 oz	0.6 oz	0.12 oz. or 0.5 teaspoonful.
Contact sprays.										
Nicotine sulphate (40%), 1 to 800=½ pt. to 50 gals.	1 qt	1.5 pts	1 pt	8 fl. oz	4 fl. oz	3.2 fl. oz	2.4 fl. oz	1.6 fl. oz	0.8 fl. oz	1 teaspoonful.
Nicotine sulphate (40%), 1 to 1,066=⅜ pt. to 50 gals.	1.5 pts	1.12 pts	12 fl. oz	6 fl. oz	3 fl. oz	2.4 fl. oz	1.8 fl. oz	1.2 fl. oz	0.6 fl. oz	0.75 teaspoonful.
Kerosene emulsion (66%), 10% strength	30 gals	22.5 gals	15 gals	7.5 gals	3.75 gals	3 gals	2.25 gals	1.5 gals	3 qts	1.2 pints.
Fish-oil soap, 1 lb. to 4 gals				12.5 lbs	6.25 lbs	5 lbs	3.75 lbs	2.5 lbs	1.25 lbs	4 oz.
Fungicides.										
Lime-sulphur concentrate [1] (33° B.), 1½ gals to 50 gals.	6 gals	4.5 gals	3 gals	1.5 gals	3 qts	2.4 qts	1.8 qts	1.2 qts	0.6 qt	4 fl. oz.
Bordeaux mixture (4–4–50); stone lime, copper sulphate.	16 lbs	12 lbs	8 lbs	4 lbs	2 lbs	1.6 lbs	1.2 lbs	0.8 lb		
Self-boiled lime-sulphur mixture [1] (8–8–50); stone lime, sulphur.	32 lbs	24 lbs	16 lbs	8 lbs	4 lbs	3.2 lbs	2.4 lbs			
(B) SPRAY MATERIAL AND USUAL RATE OF DILUTION FOR DORMANT TREES.										
Contact sprays.										
Lime-sulphur concentrate (33° B.), 1 gal. to 8 gals.	25 gals	18.75 gals	12.5 gals	6.25 gals	3.12 gals	2.5 gals	1.87 gals	1.25 gals	2.5 qts	1 pint.
Lime-sulphur concentrate (33° B.), 1 gal. to 9.5 gals.	21 gals	15.75 gals	10.5 gals	5.25 gals	2.62 gals	2.1 gals	1.57 gals	1.05 gals	2 qts	0.84 pint.
Kerosene emulsion (66%), 25% strength	76 gals	57 gals	38 gals	19 gals	9.5 gals	7.6 gals	5.7 gals	3.8 gals	1.9 gals	3 pints.
Kerosene emulsion (66%), 20% strength	60 gals	45 gals	30 gals	15 gals	7.5 gals	6 gals	4.5 gals	3 gals	1.5 gals	2.4 pints.
Fish-oil soap, 2 lbs. to 1 gal	400 lbs	300 lbs	200 lbs	100 lbs	50 lbs	40 lbs	30 lbs	20 lbs	10 lbs	2 lbs.

[1] Also serves as a contact spray during the summer season for newly hatched scale insects.

Abbreviations: oz.=ounce; lb.=pound; fl. oz.=fluid ounce; pt.=pint; qt.=quart; gal.=gallon. Weights: 16 ounces=1 pound. Measures: 7 teaspoonfuls=1 fluid ounce; 16 fluid ounces=1 pint; 32 fluid ounces=1 quart; 4 quarts=1 gallon.

SOME IMPORTANT INSECTS AND THEIR TREATMENT.

APPLE INSECTS.

CONTROLLED BY WINTER OR DORMANT TREE SPRAYING.

San Jose scale.[1]—The San Jose scale infests the trunk, limbs, and branches of most fruit trees—apples, pears, peaches, plums, etc. The mature scale (see fig. 35) is about the size of a pinhead, circular in outline, grayish in color, with a nipple-like prominence in the center. The bark of badly infested trees is ash gray, and when cut into shows a reddish discoloration. In the absence of treatment young trees are usually killed in two or three seasons, and the vitality of older trees is quickly impaired and eventually they are destroyed by its attack. It is usually controlled by one thorough spraying of the trees each year, preferably with lime-sulphur solution (p. 18). Petroleum oil sprays (p. 28) also are used, but these sometimes cause injury to the trees and fruit buds. Fish-oil soap washes may be employed (p. 36), and these are convenient where only a few trees are to be treated. Badly infested trees should be sprayed in the fall as soon as the leaves are down, and again the following spring before the buds open. Ordinarily one treatment each year, preferably in the spring, will be sufficient, although thorough work is necessary to destroy the insect so that there will be no spotting of the fruit.

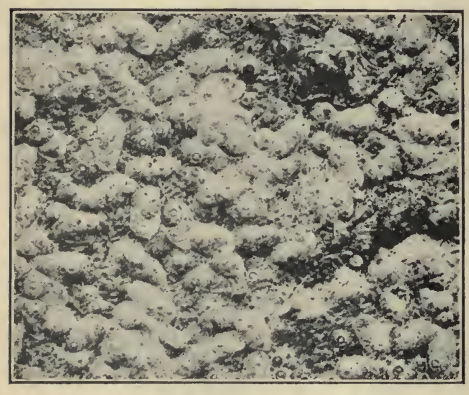

FIG. 35.—San Jose scale. Much enlarged.

Oyster-shell scale.[2]—The oyster-shell scale is readily recognized from the resemblance of its scale, or covering, to a long narrow oyster shell, as shown in figure 36. The female scale is about one-eighth of an inch long, brown to dark brown, though sometimes grayish in appearance. While less susceptible to winter treatments than the San Jose scale, the oyster-shell scale will be sufficiently controlled in orchards by the lime-sulphur solution employed for the former species. When infesting apple, pear, etc., it may also be treated with kerosene emulsion or lime-sulphur spray at summer strength when the young are hatching in the spring, which for any locality will usually occur during the period of one to three weeks following the blooming of the apple, or, in the case of the peach, with self-boiled lime-sulphur mixture in from two to four weeks following the blooming of the peach.

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[1] *Aspidiotus perniciosus* Comstock.

[2] *Lepidosaphes ulmi* Linnaeus.

Scurfy scale.[1]—Although not often very injurious to orchard trees the scurfy scale (fig. 37) is the subject of frequent inquiry from fruit growers and others. The treatment recommended for the San Jose scale will aid much in keeping this species in check, and it may be treated with dilute scale washes as the young are hatching in the spring, as just described for the oyster-shell scale.

Pear-leaf blister mite.[2]—The very minute creature known as the pear-leaf blister mite in recent years has become an important apple pest in some localities. It is controlled by the dormant tree treatments recommended for the control of the San Jose scale (see under "Pear insects," p. 84).

Apple aphids.—Principally three kinds of aphids are important pests of apple foliage, namely, the rosy aphis,[3] the green aphis,[4] and the oat aphis.[5] These are small greenish or pink plant-lice which curl the leaves or distort the fruit. They winter on the apple in the egg stage, the young hatching and congregating on the buds just as the green shoots are pushing through the bud scales. (Fig. 38.) Thorough spraying at this time should prevent important injury later in the season. Forty per cent nicotine sulphate is used at the rate of three-fourths of a pint per 100 gallons of spray. If the dormant-tree treatment for the San Jose scale with lime-sulphur solution can be delayed until the buds are breaking, the scale and aphid treatments may be combined. (See p. 82.)

FIG. 36.—Oyster-shell scale. Considerably enlarged.

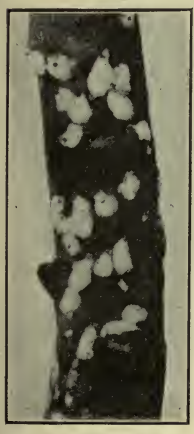

FIG. 37.—Scurfy scale. Somewhat enlarged.

CONTROLLED BY SUMMER SPRAYING AND OTHER MEASURES.

Apple worm, or codling moth.[6]—The dirty white or pinkish caterpillar which feeds within the apple (fig. 39) is known as the apple worm and the adult insect, into which it develops, as the codling moth. The number of broods of larvæ each year varies from one to three or four, according to

[1] *Chionaspis furfura* Fitch.
[2] *Eriophyes pyri* Pagenstecher.
[3] *Aphis malifoliae* Fitch.
[4] *Aphis pomi* De Geer.
[5] *Aphis avenae* Fabricius
[6] *Laspeyresia pomonella* Linnaeus.

FIG. 38.—Aphids clustered on expanding apple bud; proper time to make "bud spray." Considerably enlarged.

latitude and altitude. The insect is well controlled by the timely use of arsenical sprays, the number of applications varying with different regions. A spray schedule for apple orchards is given on page 82.

Lesser apple worm.[1]—The lesser apple worm infests the fruit much as does the codling moth, but the burrows are not usually so deep, and it mines more under the skin in the calyx basin or on the sides of the fruit. The larva is smaller than that of the codling moth and is pinkish and fusiform. The treatments recommended for the codling moth will be effective in controlling the lesser apple worm.

Plum curculio.[2]—The plum curculio is one of the causes of knotty, deformed apples (fig. 40). The small snout-beetles puncture the young fruit in the early spring while feeding and egg laying, causing much of the fruit to fall or to become misshapen as it grows, thereby destroying or lessening its market value. In addition, the beetles, while feeding in the fall, excavate small holes or cavities in the ripening fruit, which favor its decay by fungi or other causes. The spray applications recommended for the codling moth (page 82) will aid much in reducing curculio injury to apples, although in the case of orchards in sod, or more or less grown up in or surrounded by weeds or other vegetation, sprays are not entirely satisfactory and these conditions should be corrected.

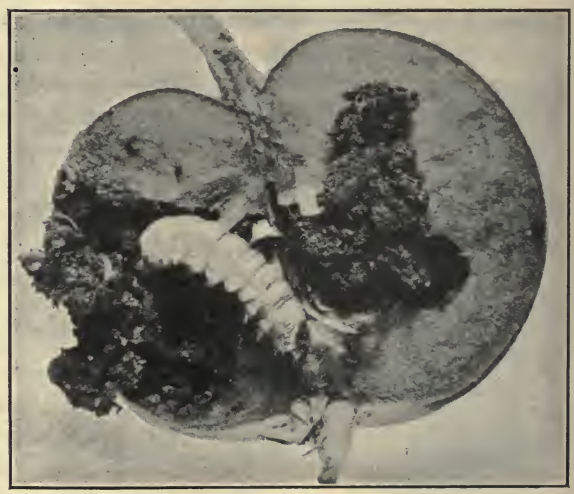

FIG. 39.—Codling moth or apple worm and its injury to apple.

[1] *Laspeyresia prunivora* Walsh.

[2] *Conotrachelus nenuphar* Herbst.

The apple maggot.[1]—The apple maggot, known also as the "railroad worm," makes discolored patches or winding burrows here and there in the flesh of the apple, and several larvæ in a fruit usually will reduce the pulp to a slimy brownish mass. The insect is more or less prevalent throughout the Northeastern States. It prefers sweet and subacid varieties. Some experimenters have found that if the foliage and fruit are kept covered with a poison, such as arsenate of lead, during early July, the flies are destroyed before egg laying begins to any extent. Experience with this insect in Canada is to the effect that sprays regularly applied for the control of the codling moth and other insects will also control the apple maggot. In the home orchard and elsewhere care should be taken to gather up promptly and destroy wormy fallen fruit.

FIG. 40.—Apples deformed by plum curculio.

Apple red bugs.[2]—The sucking insects known as apple red bugs came into prominence recently in New York State, Pennsylvania, and elsewhere. They puncture the little fruits early in the season, causing them to fall or become pitted and deformed (fig. 41.) Best control comes from the use of 40 per cent nicotine sulphate, 1 pint to 100 gallons of spray, added to the first scab treatment before the blossoms open. It may also be necessary to add the nicotine sulphate to the first codling-moth treatment after the falling of the petals. (See "Spraying schedule," p. 82.)

FIG. 41.—Apples deformed by apple red bugs.

[1] *Rhagoletis pomonella* Walsh.

[2] *Heterocordylus malinus* Reuter and *Lygidea mendax* Reuter.

Bud moth.[1]—The caterpillars of the bud moth attack the opening buds of the apple in the spring, and it is particularly destructive throughout the northern United States, extending west to the Pacific coast. The dark-brown caterpillars hibernate about half grown in little cases around the buds, and as the little leaves expand in the spring these are folded together by threads of silk and the caterpillars feed within the folded leaves. Injured leaves often turn brown, and if the caterpillars are abundant their work is quite conspicuous. During late summer the young larvæ of the new brood eat small holes in the apples, causing important blemishes. In seriously infested orchards a spray of arsenate of lead, 2 pounds of the powder (or 4 pounds of the paste) to 50 gallons of water or lime-sulphur solution, should be applied when the flower clusters are first in evidence. The arsenical in the first scab treatment just before the flowers are opened will effect further control. After the pest is well reduced the usual spraying schedule should keep it in check.

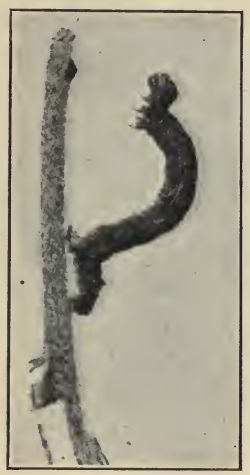

FIG. 42.—Spring cankerworm. Somewhat enlarged.

Cankerworms.[2]—The cankerworms are slender measuring worms, about 1 inch long when full grown, that feed upon the foliage of various fruit and other trees, but especially the apple and elm. (Fig. 42.) The leaves are attacked shortly after they put out in the spring and may be quickly devoured, leaving the trees brown as if swept by fire. Orchards well sprayed as for the codling moth suffer little. Injury to young orchards can be stopped by spraying with arsenate of lead promptly upon first signs of injury. Cultivation of orchards during early summer destroys many pupæ in the ground. Large apple and shade trees may be protected by using bands of sticky substances, cotton batting, etc., around the trunk (p. 55). For the fall cankerworm these bands should be in place in late fall (October), and for the spring form some 4 or 5 weeks before the buds are due to open.

FIG. 43.—Apple-tree tent caterpillar and nest; egg mass on twig on the right.

[1] *Tmetocera ocellana* Schiffermüller.

[2] The spring cankerworm (*Paleacrita vernata* Peck) and the fall cankerworm (*Alsophila pometaria* Harris).

Apple-tree tent caterpillar.[1]—In the spring the apple-tree tent caterpillars make their unsightly nests, or tents, in trees along the roadside, streams, neglected orchards, etc. (fig. 43). The wild cherry is their favorite food, though numerous other plants are attacked when the caterpillars are abundant. They are rarely of much importance in well-sprayed orchards. The egg masses on the twigs should be searched for when the trees are leafless, and destroyed, and in the spring the nests should be torn out and the caterpillars killed. Rags saturated with kerosene on the end of a pole may be used to destroy caterpillars in their nests in the higher parts of the trees.

Apple aphids.[2]—Plant-lice, or aphids, often become abundant on the apple trees during spring and summer. They are best treated as the buds are breaking (p. 77), but if the insects continue abundant when the first scab treatment is due, 40 per cent nicotine sulphate at the rate of three-fourths pint to 100 gallons of spray should be added to the dilute lime-sulphur solution. It may be advisable to use the nicotine in the first codling-moth treatment also, if the aphids continue destructive, though it will serve merely to check them. The green aphis[3] is sometimes so abundant during summer, especially on young trees, as to warrant treatment, but satisfactory control is difficult on account of the curled condition of the leaves.

Fig. 44.—Roundheaded apple-tree borer and its injury to young apple tree.

Roundheaded apple-tree borer.[4]—The roundheaded apple-tree borer infests the apple, quince, pear, and numerous wild plants, especially the service-berry, mountain ash, and crab. Trees are attacked at or near the base, the larvæ feeding the first season under the bark and during the second and third years entering the wood. A few borers in a young tree may kill it, and older trees are always greatly injured by them (fig. 44). Fruit trees subject to attack should be wormed each year, care being taken not to injure the bark and wood more than necessary (p. 45). The beetles are laying eggs during May and

[1] *Malacosoma americana* Fabricius.
[2] *Aphis malifoliae* Fitch, *Aphis pomi* De Geer, and *Aphis avenae* Fabricius.
[3] *Aphis pomi* De Geer.
[4] *Saperda candida* Fabricius.

June and less actively until September. They may be largely deterred from egg laying by coating the trunk of the trees, from 3 to 4 inches below the ground to about 1 foot above, with paint (p. 48). It will often be practicable to remove from the neighborhood of orchards wild host plants, such as service-berry trees and the mountain ash.

Woolly apple aphis.[1]—The woolly apple aphis occurs on the limbs and twigs of apple as bluish-white colonies, or patches, but is more injurious to the roots, which become knotty and deformed, thereby stunting the trees and at times resulting in their death, especially during periods of drought. (Fig. 45.) Trees found to be suffering from the woolly aphis at the roots should be given especial care as to fertilization and cultivation, to enable them to grow in spite of the presence of the insect. Lack of growth due to unfavorable soil conditions is often attributed to this insect. Colonies of aphids on limbs and branches may be controlled with contact sprays, such as petroleum oils (p. 28).

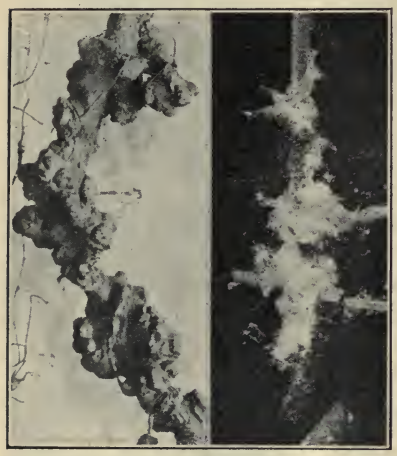

FIG. 45.—Woolly apple aphis: Injury to root on left, and colony on twig on right.

APPLE SPRAYING SCHEDULE.[2]

DORMANT TREE SPRAYING.

During the dormant period of trees sprays may be used much stronger than at other times, and for this reason dormant tree spraying is especially advisable for the treatment of scale insects, the blister mite, etc. Applications may be made after the leaves have fallen in the fall, during warm days in the winter, or in the spring before the new growth begins to appear. Where aphids are troublesome it is often practicable to delay the San Jose scale treatment until just as the buds are breaking (fig. 38, p. 78), and, by adding nicotine to the strong lime-sulphur solution, effect a combination treatment for both the scale and aphids.

SUMMER SPRAYING.

First application.—Use concentrated lime-sulphur solution (33° Baumé) at the rate of 1½ gallons to 50 gallons of water plus 2 pounds of arsenate of lead paste (or 1 pound of powdered arsenate of lead) just before the blossoms open (fig. 46). This is for apple scab, the

[1] *Eriosoma lanigerum* Hausmann.

[2] Directions for use of fungicides furnished by Bureau of Plant Industry.

plum curculio, cankerworms, the bud moth, case-bearers, and the tent caterpillar. Add about one-half pint of 40 per cent nicotine sulphate if apple red bugs are troublesome and if apple aphids are much in evidence.

Second application.—Use same spray as in first application as soon as the blossoms have fallen (fig. 47). This is for the above-mentioned troubles as well as for the codling moth and leaf-spot. It is the most important application for both apple scab and the codling moth. In spraying for the codling moth at this time the aim is to drive into the calyx end of each little apple a quantity of the poison, and, to accomplish this, painstaking work is necessary. *Failure to do thorough spraying at this time for the codling moth can not be remedied by subsequent applications.*

FIG. 46.—Cluster of apple blossoms in the "pink" stage, when first curculio and scab treatment should be made.

FIG. 47.—Apple blossoms from which petals have just fallen; the right time to make "calyx spray" for the codling moth.

Third application.—Use the same spray indicated above, three to four weeks after the blossoms have fallen. This is the second treatment for the codling moth and leaf-spot, and gives further protection against apple scab and certain insects. In orchards in which blotch has been prevalent this application should be made not less than three weeks after the blossoms have fallen. Where this disease has been severe, Bordeaux mixture (3–4–50, p. 38) should be substituted for the lime-sulphur solution.

Fourth application.—Use Bordeaux mixture (4–4–50) and an arsenical eight to nine weeks after the petals have fallen. This is the first application for the second brood of the codling moth and for bitter-rot. In orchards in which bitter-rot has been a serious disease this application should be advanced about one week.

Fifth application.—Use Bordeaux mixture from two to three weeks after the fourth application. This is the second application for bitter-rot, and since it is very little extra expense to add an arsenical, this may be profitably done as a further protection against late-appearing larvæ of the codling moth.

FIG. 48.—Pear-leaf blister mite, showing injury to apple leaf.

Sixth application.—Use Bordeaux mixture again two or three weeks after the fifth treatment has been applied. This is the third application for bitter-rot and is ordinarily sufficient to carry the fruit through, but on specially susceptible varieties in bitter-rot sections a treatment to be made two weeks later may be found necessary.

Seventh application.—In severe cases of bitter-rot a seventh application may be necessary, and in severe cases of blotch an extra treatment midway between the third and fourth applications is sometimes required.

NOTE.—In the more northern apple-growing sections the first four applications, during ordinary seasons, will be sufficient to protect the fruit from various insects and diseases mentioned. In the more central States, where bitter-rot and blotch are prevalent, the fifth and sixth applications will be necessary. In the case of summer apples only the first three applications are needed.

PEAR INSECTS.

CONTROLLED BY WINTER OR DORMANT TREE SPRAYING.

San Jose scale.[1]—The San Jose scale infests pears (except Kieffer and LeConte varieties), and should be treated as described for the San Jose scale on apple (p. 76).

Pear-leaf blister Mite.[2]—The leaf blister mite is usually present wherever pears are grown and frequently requires treatment on

[1] *Aspidiotus perniciosus* Comstock. [2] *Eriophyes pyri* Pagenstecher.

pears as well as on apples. The mites winter behind the bud scales and attack the unfolding leaves and young fruit in the spring, causing reddish or greenish blisterlike spots which, later in the season, become brown and dead (fig. 48). If the attack is severe, the foliage may fall, stunting the fruit and in extreme cases causing it to shed. The lime-sulphur and oil sprays used for the San Jose scale (p. 76) keep the blister mite in check.

CONTROLLED BY SUMMER SPRAYING AND OTHER MEASURES.

Codling moth.[1]—The apple worm also attacks the pear, in some localities quite seriously. It should be treated as recommended for the apple; the second, third, and fourth applications of the apple spraying schedule being sufficient.

FIG. 49.—Pear slug and its injury.

Pear slug.[2]—The pear slug skeletonizes the leaves of the pear, cherry, and to some extent the plum. The slimy snail-like larvæ (fig. 49) appear on the trees in May or June, according to latitude. A second brood may be in evidence about midsummer. The pest is easily controlled by arsenicals sprayed or dusted on the foliage, or by the use of contact sprays.

Pear-tree psylla.[3]—The pear-tree psylla is very troublesome in some regions and careful and persistent work is required to keep it under control. The insects suck out the sap from the foliage and leaf stalks, causing the leaves to turn yellow, and later brown, and many of these fall prematurely, with consequent injury to the fruit. Infested trees are usually sooty in appearance, resulting from the growth of a black fungus on the sticky excrement or honeydew voided by the insects. Adults hibernate in cracks in the bark of the trunk and limbs, under bark scales, or under trash on the ground. Special attention should be given to the destruction of the hibernating insects by scraping off the rough bark of the trunk and limbs, and spraying the trees thoroughly before the adults go into hibernation in the fall, or before they emerge from hibernation in the spring. Days should be selected when the sprays will not freeze on the trees. An effective winter spray is made up as follows: Forty per cent nicotine sulphate, three-fourths of a pint; fish-oil soap, 3 to 5 pounds; water, 100 gallons. Psylla eggs about to hatch, and young nymphs,

[1] *Laspeyresia pomonella* Linnaeus. [2] *Eriocampoides limacina* Retzius. [3] *Psylla pyricola* Förster.

may be successfully treated in early spring as the blossoms in the cluster buds are spreading, using winter-strength lime-sulphur solution. It usually will be practicable to defer the application for the San Jose scale until this time. Nymphs of the first brood (fig. 50) mostly congregate in the axils of the young leaves and fruit, and may again be treated with the nicotine-soap spray, above mentioned, applied just after the blossoms have fallen, arsenate of lead being added for the codling moth.

Fig. 50.—Pear-tree psylla: Immature stage. Greatly enlarged.

Pear thrips.[1]—The adult pear thrips come from the ground in the spring as the bud scales are spreading, and owing to their minute size are able to work their way within, where they feed upon the tender tissues of leaf and flower buds. Fruits like the pear and prune, which bear the blossoms in clusters, suffer worst, and when the insects are abundant the crop literally may be destroyed in the bud (fig. 51.) Fruit from blossoms attacked, but which escaped destruction, is likely to be deformed and scabby and of lessened market value. The pear thrips has caused large losses on the Pacific coast, and more recently has become established in the Hudson Valley, in Maryland, and elsewhere in the East. It is controlled by spraying with nicotine and soap, or nicotine-distillate spray (p. 30) when the buds first begin to open, and again after falling of blossoms. A second "bud application" is desirable when the insects are very abundant. Best results follow the use of a coarse spray under high pressure and directed from above into the opening buds.

FIG. 51.—Pear thrips: Injury to blossoms and foliage of pear.

QUINCE INSECTS.

With one exception, the more important insects attacking the quince were discussed under apple (p. 76).

[1] *Taeniothrips inconsequens* Uzel.

Quince curculio.[1]—The quince curculio is much the most important insect enemy of the fruit of the quince. Its attack causes the fruit to become wormy and knotty, and in some regions its injuries may result in a loss of over 90 per cent of the crop. It is controlled with difficulty. Thorough spraying with strong arsenate of lead spray when the beetles first appear, repeating the application about a week later, is of value. Injury may be reduced also by capturing the beetles with curculio catchers or jarring them onto sheets placed on the ground or held under the trees (p. 52).

FIG. 52.—Terrapin scale on peach twigs.

FIG. 53.—Peach twig-borer injury to peach shoot in the spring.

Roundheaded apple-tree borer.[2]—The roundheaded apple-tree borer is often more injurious to quince than to apple. (See p. 81.)

PEACH INSECTS.

CONTROLLED BY WINTER OR DORMANT TREE SPRAYING.

San Jose scale.—The San Jose scale requires treatment on peach, and the winter strength lime-sulphur solution should be used on stone fruits in preference to oil sprays. (See "Spraying schedule," p. 89.)

Terrapin scale.[3]—In some regions the terrapin scale (fig. 52) is very troublesome on the peach and plum. The honeydew or excrement voided by the scales furnishes a medium for the growth of a black mold which covers the foliage and fruit, lessening the market value of the latter. Lime-sulphur sprays are not effective against this pest, and a miscible oil (p. 31) should be applied in the spring just as the buds begin to swell.

Peach twig-borer.[4]—The peach twig-borer tunnels into the tender shoots of the peach (fig. 53) in the spring and later attacks the fruit

[1] *Conotrachelus crataegi* Walsh.
[2] *Saperda candida* Fabricius.
[3] *Lecanium nigrofasciatum* Pergande.
[4] *Anarsia lineatella* Zeller.

Fruit injury is especially common in California and other western States. The insect winters as a very small larva in burrows in the bark, in the crotches of the limbs, where it may be destroyed by spraying the trees during the dormant period with winter-strength kerosene emulsion (p. 28). Lime-sulphur solution, as used for the San Jose scale (see "Spraying schedule," p. 89), is effective if applied as the buds begin to swell in the spring.

CONTROLLED BY SUMMER SPRAYING AND OTHER MEASURES.

Plum curculio.[1]—The little snout-beetle known as the plum curculio punctures the fruit for egg-laying and feeding purposes, causing it to fall or become knotty or distorted (fig. 54). It is best controlled by the use of arsenate of lead. Peach growers should follow the peach spraying schedule given on page 90, thus controlling also the peach scab and brown-rot. These three troubles are much the most important ones of the fruit and may be largely prevented.

FIG. 54.—Injury by plum curculio to peaches.

Peach borer.[2]—The peach borer attacks the tree at or below the ground, eating out patches or burrows in the inner bark (fig. 55), and its presence is usually indicated by the exudation from the crown of a mass of gum more or less mixed with dirt and frass. It is a most serious enemy of the peach and to a less extent of other stone fruits, and in most regions must be controlled to prevent destruction of the trees. There is no known method of control more satisfactory than carefully worming the trees in the spring and fall of each year (p. 45). A related species[3] occurs on the Pacific coast, for which the same control measures are recommended.

Lesser peach borer.[4]—The lesser peach borer affects principally the trunk and branches of the peach, plum, and cherry. It follows injury to the bark, as from the effects of freezing, barking during cultivation, etc. Its attacks are best prevented by avoiding mechanical injury to the trunk and limbs. Injured bark should be cut out and the exposed parts of the tree thoroughly coated with suitable paint (p. 48). Thorough worming is desirable in fall and spring while worming for the peach borer (p. 45).

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[1] *Conotrachelus nenuphar* Herbst.
[2] *Sanninoidea exitiosa* Say.
[3] *Sanninoidea opalescens* Henry Edwards.
[4] *Sesia pictipes* Grote and Robinson.

Fruit-tree barkbeetle.[1]—The fruit-tree barkbeetle, also called the shot-hole borer, attacks most fruit trees as well as related wild plants. Small holes are eaten in the bark, and in stone fruits its injury is usually indicated by the exudation of gum, often copiously (fig. 56). The beetles prefer sickly or diseased trees, or those in a weakened condition from any cause. Such trees when once attacked may be quickly destroyed, and the beetles, on account of their abundance, are thus often thought to be the real cause of the trouble. Injury is best avoided by maintaining trees in a vigorous growing condition, by cultivation, fertilization, pruning, etc. Trees recently attacked may often be saved by severe pruning and fertilization with a nitrogenous fertilizer. Thorough coating of the trunk or branches with heavy whitewash (p. 48) is desirable, as this interferes with the activities of the beetles.

FIG. 56.—Exudations of gum from peach following attack by the fruit-tree barkbeetle.

FIG. 55.—Peach borer and its work on young peach tree.

PEACH SPRAYING SCHEDULE.[2]

DORMANT TREE SPRAYING.

Use lime-sulphur concentrate (p. 18) at the rate of about 7 gallons for each 50 gallons of water. This is for the San Jose scale, and if applied just before the buds are due to swell in the spring it will also control peach leaf-curl and the peach twig-borer.

[1] *Scolytus rugulosus* Ratzeburg.

[2] Directions for the use of fungicides furnished by the Bureau of Plant Industry.

SUMMER SPRAYING.

In the eastern half of the United States most of the peach orchards should be given the combined treatment of arsenate of lead and self-boiled lime-sulphur mixture for curculio, scab, and brown-rot. The latter disease is more especially troublesome in the South, whereas peach scab is worst in the Allegheny Mountain region and in the Northern States. Peach spraying is now largely practiced by commercial orchardists (fig. 57) with excellent results.

FIG. 57.—Spraying in Georgia peach orchard with self-boiled lime-sulphur mixture and arsenate of lead.

Midseason varieties.—The midseason varieties of peaches, such as Reeves, Belle, Early Crawford, and Elberta, should be sprayed as follows:

(1) With 2 pounds of arsenate of lead paste (or 1 pound of arsenate of lead powder) per 50 gallons of water, to which has been added the milk of lime made from slaking 3 or 4 pounds of stone lime, about 10 days after the petals have fallen, or at the time the calyces are shedding (fig. 58).

(2) With self-boiled lime-sulphur mixture (p. 25) and arsenate of lead, two weeks later, or four to five weeks after the petals have been shed.

(3) With self-boiled lime-sulphur mixture (omitting the arsenical) four or five weeks before the fruit is due to ripen.

FIG. 58.—Young peaches at the stage of growth when "shucks" are falling; proper time for first application of spray for curculio.

Late varieties.—The Salway, Heath, Bilyeu, and other varieties with a similar ripening period should receive the same treatment prescribed above, with an additional application of self-boiled lime-sulphur mixture alone, to be applied three or four weeks after the second application.

Early varieties.—The Greensboro, Carman, Hiley, Mountain Rose, etc., and varieties of the same ripening period should receive the first and second applications only, as prescribed for mid-season varieties.

PLUM AND CHERRY SPRAYING.

Japanese plums should receive the same treatment as peaches having the same ripening season. Soap (p. 36) should be added in the third application to enable the spray to stick to the smooth plum fruits.

Plums other than the Japanese varieties should receive the treatment outlined in the peach-spraying schedule, except that lime-sulphur solution diluted at the rate of 1 gallon to 40 gallons of water is to be preferred to the self-boiled lime-sulphur mixture.

FIG. 59.—Cherries at proper stage of growth for first spray application for curculio.

Cherries should receive the same treatment as early varieties of peaches (fig. 59), except that lime-sulphur solution diluted at the rate of 1 gallon to 40 gallons of water should be used in place of the self-boiled lime-sulphur mixture. Where leaf-spot has been severe this solution should also be used in the first treatment. For the control of leaf-spot an application of the diluted lime-sulphur solution should also be made as soon as the fruit has been picked.

FIG. 60.—Injury to cherries by the black cherry aphis.

CHERRY INSECTS.

CONTROLLED BY WINTER OR DORMANT TREE SPRAYING.

Cherry scale.[1]—The cherry scale resembles closely the San Jose scale and sometimes requires treatment on cherry. Lime-sulphur solution is used as for the San Jose scale. See peach spraying schedule (p. 89).

Cherry aphis.[2]—The cherry aphis is a black, shiny aphid which curls the tender foliage of the cherry in the spring and summer, often severely checking the growth of the trees (fig. 60). It winters on

[1] *Aspidiotus forbesi* Johnson.

[2] *Myzus cerasi* Fabricius.

the trees in the egg stage, and the young aphids upon hatching congregate on the opening buds. Thorough spraying as the buds are breaking with a nicotine-soap spray (p. 40) or with nicotine in winter strength lime-sulphur spray as for apple aphids (p. 82) will be effective. Summer spraying is of comparatively little value, the insects being protected from the spray by the curled-up leaves.

FIG. 61.—Egg and feeding punctures of plum curculio on cherry.

CONTROLLED BY SUMMER SPRAYING AND OTHER MEASURES.

Plum curculio.[1]—The plum curculio seriously injures the cherry (fig. 61) and with brown-rot is controlled by the schedule of spray applications given for the peach (p. 90). The first and second treatments only are necessary.

Cherry fruit flies.[2]—In some parts of the northern United States cherries are often more or less infested by the maggots of two species of fruit flies. There is often little external evidence of infestation, though well ripened cherries may become more or less shrunken (fig. 62). Wormy cherries thus are often gathered for market or cooking purposes, the infestation being discovered first when the maggots which have deserted the fruit are found on the bottom of the container. The adult flies feed more or less before egg laying and, it is stated, can be killed if the foliage is kept covered with a poison spray. A good spray for this purpose is arsenate of lead paste 2½ pounds (or 1¼ pounds of the powder), cheap molasses 1½ gallons, and water to make 50 gallons. The first application should be given in early June and occasionally repeated during the succeeding three or four weeks, depending upon the rains. Some cherry growers report that it is unnecessary to sweeten the spray.

FIG. 62.—Cherry infested with maggot of cherry fruit fly.

Pear slug.[3]—(See under pear, p. 85).

Peach borer.[4]—(See under peach, p. 88).

[1] *Conotrachelus nenuphar* Herbst.
[2] *Rhagoletis cingulata* Loew and *Rhagoletis fausta* Osten-Sacken.
[3] *Eriocampoides limacina* Retzius.
[4] *Sanninoidea exitiosa* Say

Cherry leaf-beetle.[1]—The cherry leaf-beetle (fig. 63) occurs sometimes in enormous numbers in the northern and more eastern States, attacking the foliage and fruit of the cherry, and to a less extent the foliage of the peach. A careful lookout should be kept for the beetles, and upon their first appearance trees should be sprayed with arsenate of lead at the rate of 5 pounds of the paste (or 2½ pounds of the powder) to 50 gallons of water. The addition of 1½ gallons of molasses to the spray is said to increase its effectiveness.

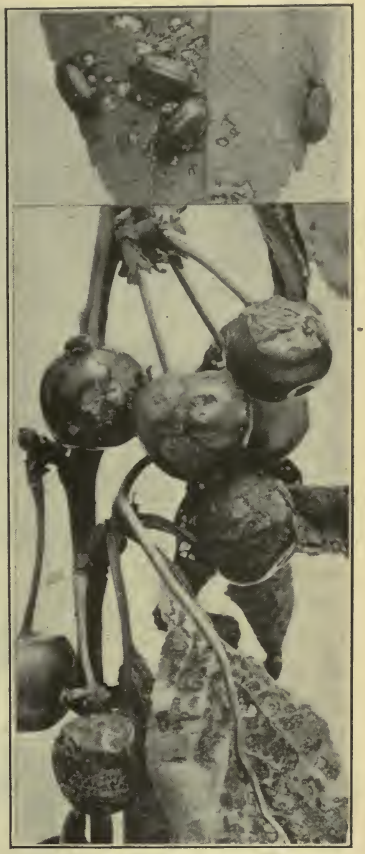


FIG. 63.—Cherry leaf-beetle and its injury to foliage and fruit of the cherry.

PLUM INSECTS.

Several of the insects injurious to the peach, already considered, attack also the plum, as the San Jose scale, the terrapin and other lecanium scales, the plum curculio (fig. 64), the peach borer, etc. See "Spraying schedule" for control of plum curculio and brown rot (p. 90).

Plum aphids.[2]—Three species of plant-lice are common on plums and often require treatment. These winter on the trees in the egg stage, the aphids hatching in the spring about the time the buds are breaking, and later may become very numerous (fig. 65). In localities where injury is usual each year trees should be sprayed as the buds are breaking, as described for apple aphids (p. 77). Otherwise it will be sufficient to spray when the aphids are actually trouble-

FIG. 64.—Plums showing egg and feeding punctures of the plum curculio.

[1] *Galerucella cavicollis* Le Conte.

[2] *Aphis setariae* Thomas, the rusty plum aphis; *Phorodon humuli* Schrank, the hop aphis; *Hyalopterus arundinis* Fabricius, the mealy plum aphis.

some, using 40 per cent nicotine sulphate, three-fourths of a pint to 100 gallons of soapy water, or in the self-boiled lime-sulphur mixture and arsenate of lead spray described in the spraying schedule (p. 90).

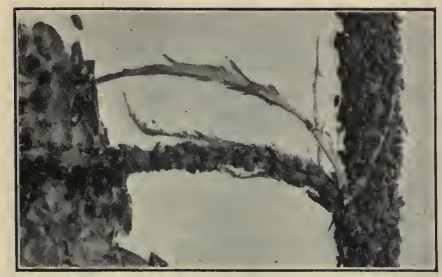


FIG. 65.—Colony of the rusty plum aphis on plum.

GRAPE INSECTS.

CONTROLLED BY SUMMER SPRAYING.

Grape-berry moth.[1]—In late summer grape berries are often found infested by an active, greenish caterpillar about three-eighths of an inch long, the larva of the grape-berry moth. It is at present destructive in northern Ohio and to a less extent in portions of the Chautauqua and Erie grape belts. First-brood larvæ feed on the blossom or young fruit clusters, and those of the second brood injure the green and ripening berries, often so soiling the bunches that they must be carefully picked over by hand before marketing. (Fig. 66.) The insect is well controlled by an arsenate of lead spray of 3 pounds of paste (or 1½ pounds of powder) to 50 gallons of Bordeaux mixture, applied by the "trailer" method (fig. 67) just after the blossoms have fallen, and again two weeks later. (See "Spraying schedule," p. 98).

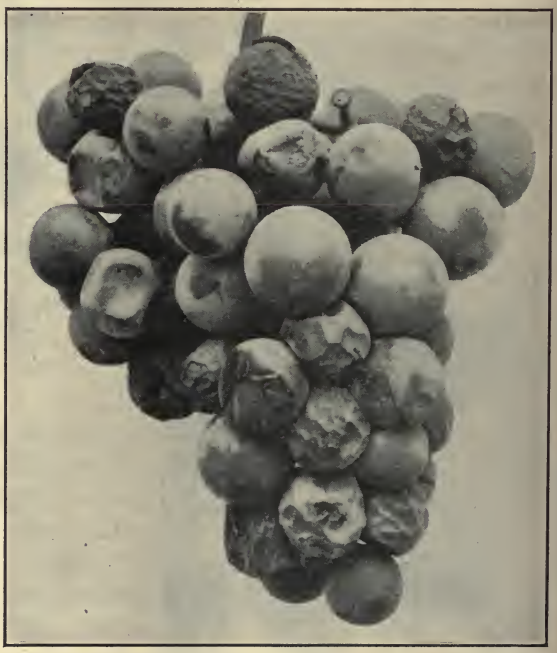


FIG. 66.—Grapes injured by grape-berry moth larvæ.

Grape rootworm.[2]—The presence of the grape rootworm in vineyards is shown by chain-like feeding marks of the adult beetles on the foliage (fig. 68). The larvæ consume the fibrous roots of the grape and eat out furrows in the larger roots, stunting the growth of the vine, so that the foliage becomes yellowish, and the fruit may

[1] *Polychrosis viteana* Clemens. [2] *Fidia viticida* Walsh.

shrivel and fall. It is a serious pest in the Erie-Chautauqua and northern Ohio grape districts and requires annual treatments to keep it reduced below injurious numbers. Since the beetles feed on the leaves during early summer and before egg laying to any extent, they may be controlled by the use of arsenical sprays applied in Bordeaux mixture, as for the berry moth, as described in the spraying schedule (p. 98).

FIG. 67.—Spraying grapes by the "trailer" method, the short spray rod being held in the hand. Necessary in effecting thorough treatment for grape-berry moth and grape leafhopper.

Grape leafhopper.[1]—The grape leafhopper is a small, agile, whitish insect, with red and yellow markings, often noted as abundant during summer on the lower surface of grape leaves. It feeds by sucking juices from the leaves, and its punctures cause the foliage to become blotched with white (fig. 69) and later to turn brown, and many of the leaves fall from the vines. This injury interferes with the proper ripening of the fruit and prevents normal vine growth. The insect is a pest of much importance on American varieties of grapes throughout the country generally, and especially in the Great Lakes district, and also on vinifera varieties in some regions of the West. It is controlled by the use of one-fourth pint of 40 per cent nicotine sulphate to 50 gallons of soapy water or

FIG. 68.—Characteristic chain-like feeding marks of adults of the grape rootworm.

[1] *Typhlocyba comes* Say.

Bordeaux mixture. The first application should be made when the wingless hoppers or nymphs of the first brood are present in large numbers (in the North this will be in late June or early July), as can be determined by examination. The nicotine should be used in the arsenate of lead and Bordeaux mixture spray, described in the spraying schedule (p. 98), and the "trailer" method of application followed (see fig. 67, p. 95). Much care is necessary in spraying to hit the insects on the lower surface of the leaves.

Rose-chafer.[1]—In some sections of the country the long-legged, yellow-

FIG. 69.—Mottled appearance of grape leaf following attack by the grape leafhopper.

FIG. 70.—Rose-chafer, or "rose bug": Beetles attacking chestnut blossoms.

ish-brown beetles, about one-half inch long, known as rose-chafers (fig. 70), often put in appearance in large numbers about the time of blossoming of the grape, roses, and many other garden flowers, stripping the plants of blossoms and foliage. They feed upon a large variety of plants, and when very abundant do much damage in spite of treatment. Thorough spraying upon first appearance of the beetles is recommended, using arsenate of lead, 5 pounds of the paste (or 2½ pounds of the powder) for each 50 gallons of water, repeating the application as necessary to keep the plants coated

[1] *Macrodactylus subspinosus* Fabricius.

with poison. Hand picking of beetles in the early morning may be practiced on a small scale, and bagging choice plants with mosquito netting also may be resorted to.

Grape leaf-folder.[1]—Grape leaves are often rolled or folded over (fig. 71) by an active, grass-green caterpillar about three-fourths of an inch long, the so-called grape leaf-folder. Within the folded leaf the larvæ eat out the soft leaf substance, and when numerous may cause more or less defoliation of the vines. The larvæ of the first brood appear on the vines in early summer. Well-sprayed vineyards are not seriously troubled by the leaf-folder, and its injuries are usually confined to the home vineyard. Spraying the vines with arsenate of lead when the larvæ are first in evidence will keep them in check. Hand picking of infested leaves or crushing the larvæ in the folded leaves is practicable where only a few vines are involved.

FIG. 71.—Work of grape leaf-folder on grape leaf.

Eight-spotted forester.[2]—The caterpillar of the moth known as the eight-spotted forester feeds on grape foliage and is sometimes much complained of locally. The full-grown caterpillar (fig. 72) is about 1⅓ inches long with transverse black and orange stripes or bands, and there is a distinct hump near the hind end. Larvæ are present on the vines from early June until about August. They may be controlled by the use of arsenate of lead, as described for the grape leaf-folder.

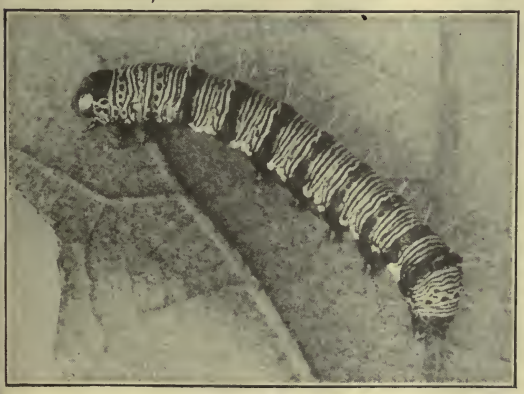


FIG. 72.—Caterpillar of the eight-spotted forester on grape leaf.

Grapevine flea-beetle.[3]—A small steely blue beetle often attacks the swelling buds of the grape in the spring. The larvæ of the beetles

[1] *Desmia funeralis* Hübner. [2] *Alypia octomaculata* Fabricius. [3] *Haltica chalybea* Illiger.

later feed upon the foliage. Where injury by this pest, known as the grapevine flea-beetle, has been prevalent or is to be expected, vines should be sprayed, as the buds are swelling, with arsenate of lead—3 pounds of paste or 1½ pounds of powder to 50 gallons of water or fungicide. This insect usually is kept in check by the arsenate of lead used in the first and second applications of the spray schedule (p. 98). This destroys the larvæ.

GRAPE SPRAYING SCHEDULE.[1]

First application.—About a week before the blossoms have opened, or when the shoots have become 12 to 18 inches long, spray with Bordeaux mixture 4–3–50 (p. 38) for fungous diseases, adding 2 to 3 pounds of arsenate of lead paste, or one-half that quantity of the powdered form, for the flea-beetle, the rose-chafer, etc.

FIG. 73.—Imported currant worm and its injury to currant leaf.

Second application.—Just after the blossoms have fallen spray with the same materials as in the first application for the same fungous diseases and insects and for the grape-berry moth, grape leaf-folder, and adults of the grape rootworm, by the "trailer" method (p. 95, fig. 67).

Third application.—About 2 weeks later use Bordeaux mixture 4–3–50, arsenate of lead paste 2 to 3 pounds, 40 per cent nicotine sulphate ¼ pint, to 50 gallons of spray mixture, for fungous diseases, berry moth, eight-spotted forester, grape leaf-folder, grapevine aphis,[2] grape rootworm, and grape leafhopper. To destroy the leafhopper, direct the spray against the lower surface of the leaves. To control the berry moth, thoroughly coat the grape bunches with the spray by the "trailer method."

Fourth application.—About 10 days later, or when the fruit is nearly grown, if black-rot or mildew are still appearing, spray with neutral copper sulphate or verdigris[3] at the rate of 1 pound to 50 gallons of water.

CURRANT AND GOOSEBERRY INSECTS.

CONTROLLED BY WINTER OR DORMANT SPRAYING.

The San Jose[4] and certain related scales are frequently present in injurious numbers on currant and gooseberry plants, the first men-

[1] Directions for use of fungicides furnished by Bureau of Plant Industry.
[2] *Macrosiphum illinoiensis* Shimer.
[3] Verdigris is basic acetate of copper.
[4] *Aspidiotus perniciosus* Comstock.

tioned especially often requiring treatment. Winter strength lime-sulphur solution is effective and should be used as directed for the control of this insect on fruit trees (p. 76).

CONTROLLED BY SUMMER SPRAYING.

Imported currant worm.[1]—The imported currant worm when full grown is about three-fourths of an inch long, uniformly green, but yellowish at the ends. Young larvæ are covered with black spots and the head is black (fig. 73). They attack both currants and gooseberries, appearing on the plants shortly after the leaves are out in the spring, feeding at first in colonies but later scattering over the plants. Currant worms are voracious feeders and quickly strip the plants of foliage, hence treatment should be given promptly upon their discovery. Another brood of larvæ appears in early summer, and some seasons there may be a partial third brood. These insects are destroyed readily with an arsenical, sprayed or dusted over the plants. Effort should be made to destroy the first brood and prevent later injury. In treating the second brood when the fruit is ripening, powdered hellebore should be used, diluted 5 to 10 times with flour or air-slaked lime, or as a spray, 1 ounce to 1 gallon of water.

FIG. 74.—Currant leaf curled by the currant aphis.

Currant aphis.[2]—The currant aphis curls the terminal leaves of the currant and gooseberry, especially the red currant, its presence resulting in little pits or pockets on the lower leaf surface (fig. 74). A reddish color usually develops on the upper surface of injured leaves, which is visible some distance away. This aphid is easily controlled by spraying the plants as the leaf-buds are opening in the spring, thus destroying the young stem-mothers. The 40 per cent nicotine sulphate-soap spray should be used, or kerosene emulsion or fish-oil soap wash. In spraying later in the season the liquid should be directed against the insects on the lower surface of the leaves.

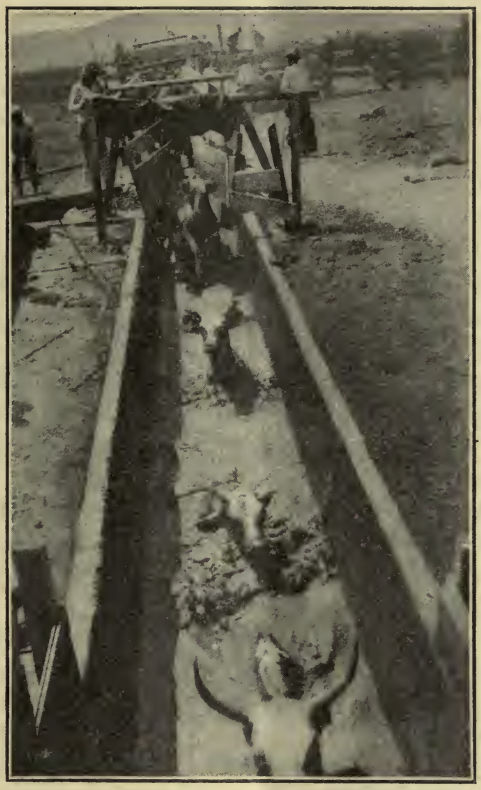
[1] *Pteronus ribesii* Scopoli.

[2] *Myzus ribis* Linnaeus.

CATTLE LICE AND HOW TO ERADICATE THEM

MARION IMES
Zoological Division

Revised Sep '40



FARMERS' BULLETIN 909

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief

Washington, D. C. February, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

CATTLE LICE are injurious to all classes of cattle, but the greatest losses occur in young stock and poorly nourished old animals. The losses are caused by irritation, digestive disturbances, arrested growth, low vitality, and increased death rate.

Three kinds of lice are commonly found on cattle, and all three species may be present on the same animal at the same time. The same method of treatment may be used for the three species.

Methods of treatment include hand applications, spraying, and dipping. The first two methods are suitable only for small herds. Dipping is the best method of applying treatment.

Arsenical dips, coal-tar creosote dips, and nicotin solutions may be used for dipping cattle to destroy lice. Two or more treatments should be given 15 to 16 days apart.

Plans of cattle-dipping plants and directions for building vats and dipping cattle are given in this bulletin.

CATTLE LICE AND HOW TO ERADICATE THEM.

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DISTRIBUTION AND ECONOMIC IMPORTANCE.

CATTLE LICE are widely distributed and have been recognized as a pest by live-stock growers since early times. These parasites are more or less prevalent in all parts of the United States, especially where cattle are held in large herds or crowded into badly kept and poorly ventilated stables. In the western range country cattle often become infested very heavily with lice, the degree of infestation varying from year to year with climatic and other conditions. In the farming communities the parasites usually are most prevalent on underfed and poorly housed cattle, although they may occur on animals in good flesh and kept in properly ventilated sanitary quarters.

Ordinarily lice on cattle are not observed until they become so numerous that they cause unmistakable signs of annoyance. Usually the animals whose lousy condition first attracts attention are the poor, weak, unthrifty members of the herd, and frequently the owner thinks they are lousy because they are unthrifty, whereas the unthrifty condition may be caused by the lice. As a rule the individual members of a herd are not affected equally, as some cattle seem to be unsuitable hosts to such an extent that they may be considered practically immune. However, when lice are introduced into a herd during the fall or winter they usually spread rapidly until every animal or nearly every animal is infested.

All kinds of cattle lice obtain their food from the tissues of their host, and the irritation caused by the parasites is evidenced by the efforts of infested animals to obtain relief by rubbing and scratching. When a herd is grossly infested it is not uncommon to see some of the animals with large areas of skin partly denuded of hair and limited areas bruised and raw from rubbing against posts and other objects. The irritation, and conditions caused thereby, result in

more loss than is commonly supposed. The lowering of the vitality and the general unthrifty condition produced by lice often result in an increased percentage of death loss among cattle during unfavorable seasons.

Calves, young stock, and old, weak, poorly nourished cattle suffer most from the ravages of lice. Heavily infested calves do not grow and thrive or gain weight normally during the winter season, and often remain stunted until the old coat of hair is shed in the spring, when most of the lice disappear. The animals then may grow and fatten, but the loss experienced during the period of arrested growth is a loss not easily regained. Lice act as a contributing cause to increase the death rate among poorly nourished cattle of low vitality, especially old range cows exposed to inclement weather. Although mature cattle in full vigor suffer less seriously from infestation with lice, nevertheless if they become very lousy they will not gain weight and there will be a loss in the production of either meat or milk. The damages and losses caused by lice are of sufficient importance to warrant careful consideration and the application of proper treatment.

FIG. 1.—Short-nosed cattle louse (*Hæmatopinus eurysternus*). Female. (Magnified about 20 times.)

Three kinds or species of lice are commonly found on cattle in the United States. Two of these are blood suckers, or suctorial lice, and are commonly known as "blue lice." The third species is a biting louse commonly known as the "little red louse."

SUCTORIAL LICE.

The short-nosed cattle louse (*Hæmatopinus eurysternus*, fig. 1)[1] usually is found on mature cattle, although it may occur on calves and young stock. The average length of adult females is about one-eighth of an inch and the body is about one-half as broad as

[1] Figures 1 to 3 are from photomicrographs by Dr. W. T. Huffman.

long. The males are slightly smaller than the females. The head is short, nearly as broad as long, and is bluntly rounded in front. The head and thorax are yellowish brown, while the abdomen is blue slate colored.

These lice pass the various stages of their life on the animal. The eggs, commonly called "nits," are attached firmly to the hairs, usually close to the skin, and they hatch on the animal in 11 to 18 days, the average period of incubation during mild weather being about 14 days. The young females begin to lay eggs when they are about 12 days old.

The long-nosed cattle louse (*Linognathus vituli*, fig. 2) usually is found on calves and young stock, but sometimes occurs on mature cattle. Although in their adult stage these lice have about the same general color as the short-nosed lice, the two species may be distinguished easily. As implied by the term "long-nosed," the head is long and slender, and the body is only about one-third as broad as long, thus giving the entire body a more slender appearance than that of the short-nosed species.

FIG. 2.—Long-nosed cattle louse (*Linognathus vituli*). Female. (Magnified about 20 times.)

These lice pass their entire life on the animal and deposit eggs in the same general manner as the other species. The eggs hatch in 10 to 14 days, the average period of incubation being about 12 days. The young females reach sexual maturity and begin laying eggs about 11 days from the date of hatching.

BITING LICE.

The common biting lice of cattle (*Trichodectes scalaris*, fig. 3) are found on both young and mature cattle. They are much smaller than the sucking lice, but are visible to the naked eye. The head is broad and blunt, the color is reddish, that of the body commonly

FIG. 3.—Biting louse of cattle (*Trichodectes scalaris*). Female. (Magnified about 20 times.)

yellowish white. They may be distinguished readily from the sucking species by the general shape of the head and body and by the color.

The life history is similar to that of the sucking lice. The average period of incubation is probably about 10 days. The eggs or "nits" are shown in figure 4.

NATURE AND HABITS.

Each species of domestic animals has its own particular species of lice, and except in accidental cases cattle lice are found only on cattle. They increase very rapidly in number on cattle during dry, cold weather when the hair is long, but when green feed comes in the spring and the animals shed the old coat of hair the lice become less numerous and seem to disappear, and they are seen rarely during the summer months. Some of the lice, however, usually remain on the animals throughout the summer, but not in sufficient numbers to do harm, as they do not increase rapidly while the animals are on green feed and in a thriving condition. With the coming of winter, when conditions again become favorable, the lice increase very rapidly. Treatment therefore should be applied in the fall while the weather is suitable and before the lice have become numerous enough to cause injury.

FIG. 4.—Eggs or nits of biting louse on a hair. The two lower eggs are unhatched; the upper one has hatched. (Magnified about 20 times.)

The sucking lice usually select locations where they are partly protected from the efforts of the animals to dislodge them. The favorite locations are the sides of the neck,

brisket, back, inner surface of the thighs, and on the head, around the nose, eyes, and ears. When animals are very lousy the entire surface of the body may become involved. The sucking lice obtain their food by puncturing the skin of the host and feeding on the blood and lymph. When feeding they attach themselves to the skin by burying their sucking tubes in the tissues. When not feeding they move about over the hair and skin.

The biting lice usually are found on the withers and around the root of the tail, but they may occur on any part of the body. They apparently feed on particles of hair, scales, and exudations from the skin. Ordinarily they do not irritate the animals as much as sucking lice. When present in large numbers, however, they often form colonies or groups around the base of the tail, over the withers, and on other parts of the animal, and produce lesions resembling those of scab. These lesions vary in size from that of a 25-cent piece to 4 or 5 inches in diameter. The skin over these areas appears to be raised and ringworm may be suspected, but when the lesion is manipulated the scarf skin falls off, exposing the lice grouped on the raw tissues beneath. Under such conditions the irritation is very great and the damage to the animal may be fully equal to that caused by scab.

When separated from their hosts the biting lice live about 7 days, the sucking lice only about 4 days. Ordinarily eggs are not deposited except on the host, but when the hair to which they are attached is removed and kept under fairly favorable conditions, they may continue to hatch for as long as 20 days. The newly hatched lice live only 2 or 3 days unless they find a host.

The longevity of the lice and the viability of their eggs when separated from the host have an important bearing on the problem of eradication. The parasites and eggs may become dislodged from the animals, drop in the corrals, stables, and pastures, and temporarily infest the premises. It seems reasonably certain that all lice that remain off the animals, even under the most favorable conditions, die within 7 or 8 days, and if the weather is cold and conditions unsuitable they die in less time. The eggs dislodged from the animals, however, may continue to hatch if the weather is mild, and thus be the means of temporarily infesting the premises.

Before using infested corrals or premises such as stables, sheds, or lots for clean or dipped cattle they should be cleaned and disinfected as a precaution against reinfection from dislodged lice and eggs. Remove all litter and manure, cleaning down to a smooth surface, then spray all walls, woodwork, and floors with a good disinfectant. The coal-tar creosote dips, diluted in accordance with instructions on the container, are suitable for this purpose. After dipping or treating animals to free them from lice they should be

taken to clean premises and not returned to the quarters previously occupied unless such quarters in the meantime have been cleaned and disinfected or held vacant for about 20 days.

The long-nosed sucking lice and the biting lice are much more easily eradicated than the short-nosed sucking lice. One treatment with arsenical dip or coal-tar creosote dip usually is sufficient to eradicate the former, but as a rule one treatment does not eradicate the short-nosed sucking lice. In fact, two treatments sometimes fail to eradicate the last-named species, especially in the case of infested bulls. When a herd is infested with all three species the animals should be given two treatments separated by an interval of 15 to 16 days. After the second treatment the cattle should be examined at frequent intervals, and if live lice are found a third treatment should be given in about 16 days following the second.

METHODS OF TREATMENT.

There are three commonly used methods of applying treatment for lice: First, hand applications; second, spraying; third, dipping. The best method to adopt naturally depends upon the season of the year, the remedies selected, the number of cattle to be treated, and the facilities available. In southern latitudes, where the winters are mild, cattle may be dipped during the winter months without injury from cold weather; but in the northern sections the weather during the winter season is usually too cold for dipping or spraying. As hand applications are practicable only when a few animals are to be treated, it is important that herds in which lice appeared during the winter be dipped the following spring or fall. Fall dipping is good insurance against both the risk of loss from lice and the probable additional expense of winter treatment. All animals in the herd should be treated regardless of the number showing infestation. If only part of the herd is treated, or if after the second treatment the animals are returned to infested premises, the parasites may spread by contact of one animal with another, or by contact with infested premises, and the herd almost certainly will become reinfested.

HAND APPLICATIONS.

Dusting powders.—The insecticidal value of many of the dusting powders is dependent upon their naphthalene and pyrethrum content, and they are of value in helping to hold in check the parasites during the season when the weather is too cold for dipping or spraying. They are sold under various trade names, but as a class they are not recommended as successful remedies for eradicating cattle lice.

Greases and liquids.—This group consists mostly of homemade remedies, which are fairly effective and practicable in cases where a farmer has only a few animals to treat and gives the matter his personal attention. While hand treatment is more or less of a makeshift even under the best conditions, it is, nevertheless, sometimes necessarily adopted. The following remedies have proved effective when applied by hand and the treatment repeated, if necessary, in about 16 days: (1) Cottonseed oil and kerosene, equal parts; (2) kerosene and lard mixed in the proportion of ½ pint kerosene to 1 pound of lard; (3) crude petroleum; (4) any of the dips recommended for use in dipping.

The first three remedies are suitable for use during mild weather, but if animals are to be treated during very warm or very cold weather it is advisable to use some of the dips instead of the oils, as the latter are liable to cause injury if the freshly treated cattle are moved rapidly, exposed to bright sunshine, or become chilled.

These remedies may be applied with a brush or a cloth. They should be distributed in a thin even coating over the surface of the head and body, including the inner surface of the ears, care being taken to see that there is no excess quantity at any point. When a dip is used for hand treatment it should be applied liberally after proper dilution over every portion of the body surface including the inner surfaces of the ears and between the thighs.

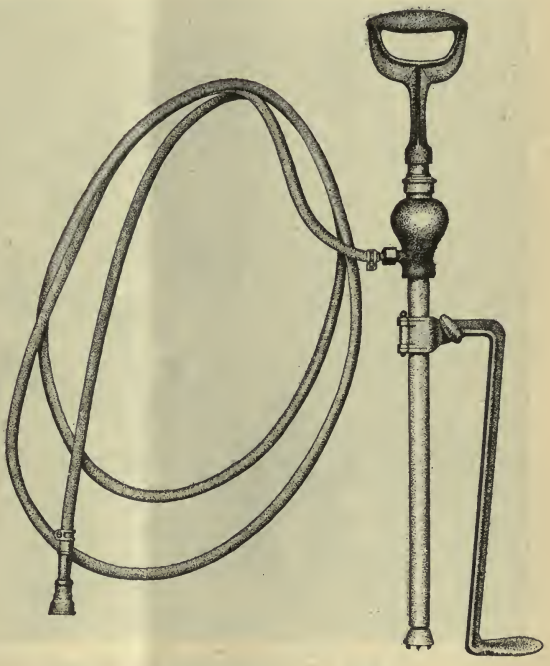

FIG. 5.—Small spray pump suitable for spraying cattle to destroy lice.

SPRAYING.

On farms where the number of animals is not large enough to justify the owner in providing a dipping vat, a spray pump may be used to advantage. Where an orchard spraying outfit is available it may be utilized for spraying animals. A small spray pump (fig.

5), which, equipped with hose and nozzles, can be purchased for less than $10, is convenient for the purpose.

Any of the dips recommended for lice may be applied in the form of a spray, and while spraying is usually not as effective as dipping, nevertheless, if the work is done well and carefully the lice can be eradicated by spraying. Two treatments should be given 15 to 16 days apart. At each spraying it is important that every portion of the surface of the body receive the maximum possible wetting, special attention being given to the head, ears, brisket, tail, and inner surfaces of the elbows, flanks, and thighs. (Fig. 6.)

FIG. 6.—Treatment for lice by means of a spray pump.

When arsenical dip is used care should be taken to see that neither the animal nor the operator breathes the spray. The operator should also be careful not to get his clothing wet with the dip.

DIPPING.

Dipping consists in immersing animals in a medicated liquid that will kill the lice. It is the most successful known method of applying treatment for lice. Dipping plants are usually arranged so that the cattle enter one end of a vat filled with dip, through which they swim, and leave the vat at the opposite end (see illustration on front page).

One dipping sometimes eradicates the lice, but it can not be depended upon in practical operations, especially when the animals are infested with the short-nosed sucking lice. The first dipping if properly done may kill all the lice or cause them to leave the animals, but it may not destroy all the eggs. Some of the eggs often survive the first dipping and hatch, thus forming a new generation of lice. To complete the treatment this new generation should be destroyed by a second dipping before they have had time to develop to maturity and deposit eggs. On the other hand, the second dipping should be delayed long enough to give the eggs which were laid before the first dipping sufficient time to hatch; otherwise they may hatch after the second dipping and reinfest the cattle. Because of overlapping of the two periods and of variations in the incubation period and the period required for lice to reach maturity it does not seem possible to meet both of these conditions in establishing the length of the interval between dippings, but a period of 15 to 16 days has generally given satisfactory results.

When conditions are such that an infested herd can not be dipped twice, one dipping in arsenical solution or coal-tar creosote dip will amply repay the cost and effort. If complete eradication is desired, however, two dippings should be given with an interval of 15 to 16 days between dippings, and sometimes a third dipping may be necessary.

DIRECTIONS FOR DIPPING.

If dipping is to be successful it is necessary to give close attention to details and see that the work is performed carefully and thoroughly. Before bringing cattle to the vat they should be watered and fed so as not to be hungry or thirsty at the time of dipping; on the other hand, they should not be gorged with feed and water when dipped. If they are watered and fed two to four hours before dipping, they are likely to be in the best condition for the operation. When cattle have been driven and are hot at the time of reaching the vat, they should be allowed to cool off before they are dipped, as it is dangerous to dip animals while they are hot. When the nights are cold dipping should be finished for the day early enough for the animals to become dry before sunset.

The dip in the vat should be maintained during dipping at a depth of 70 to 80 inches, or sufficient to swim the tallest animal to be dipped. The quantity of dip necessary to obtain that depth should be ascertained before it is prepared. The average 1,000-pound short-haired steer will carry out and retain about 2 quarts of dip, and the same class of cattle with long hair will retain about 1 gallon each. The total estimated amount of dip which the animals carry out and retain,

plus the amount required to charge the vat, should equal the total amount required, if none is lost by leakage or otherwise wasted.

The capacity of the vat is usually obtained in the following manner: Multiply the average length by the average width in inches, then the product by the depth; this will give approximately the number of cubic inches of space to be filled with dip. Divide this by 231 (the number of cubic inches in a gallon), and the result will be approximately the number of gallons of dip required to charge the vat.

To obtain the average length, add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled), and divide this sum by 2. Obtain the average width in the same manner. The depth should be taken at the center of the vat, and should be from bottom to dip line only and not to the top of the vat. Likewise, in determining the length and width, measure only the space to be filled with liquid and not above that line. The capacities of the various tanks are obtained by a like process. Gauges or rods should be prepared and marked to show the number of gallons at various depths in the vat and tanks.

FIG. 7.—Stirring plunger for mixing liquids in the vat.

After the vat is filled to the required depth the contents should be mixed well by stirring, in order that the dip may be of uniform strength throughout. A good method of stirring dip is to take a pail or an empty dip container in which a wire bail has been fastened, attach a rope or dipping fork to the bail, allow the vessel to fill and partially sink, then drag it rapidly from one end of the vat to the other, repeating the operation several times. Stirring plungers also are useful implements, and as they are easily made, one or more should be provided at every vat. Their use is similar to that of the dasher of an old-fashioned hand churn. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat. The style shown in figure 7 is one commonly used.

Before beginning dipping operations the pens, chutes, slide board, vat, etc., should be examined for projecting nails, broken boards, or any object that may puncture or wound the cattle, as the dip may injure those having fresh wounds. The animals should be handled as carefully as possible, although in dipping wild range cattle the attendants can exercise very little control in the matter. Range cattle,

not accustomed to being handled, are easier to dip than tame farm animals, as they go through the chutes and enter the vat more readily than the tame animals. After the animals have started running through the chute it is often necessary to restrain them to prevent their piling up and drowning in the vat. At large dipping plants a gate is usually provided in the chute near the intake to the vat so the animals in the chute may be held back and allowed to pass only as room is made for them in the vat. If the chute has no gate, a bar which can be slipped across the chute between the side boards will answer the purpose. Gentle farm animals, and especially old milk cows, usually do not enter the vat readily—in fact, often it is necessary to push them on the slide board.

In dipping cattle for lice it is not necessary to hold them in the vat, but they should be completely submerged and the head ducked at least once. When the heads are ducked the air inclosed in the ears may prevent the dip from wetting the inner surfaces of the ears or coming in contact with the lice attached in the lower folds. Therefore care should be taken to see that the dip enters the ears of each animal as it passes through the vat. This may be accomplished by pushing the heads low enough in the dip so the liquid fills the ears or by splashing the dip with an old broom over and into the ears.

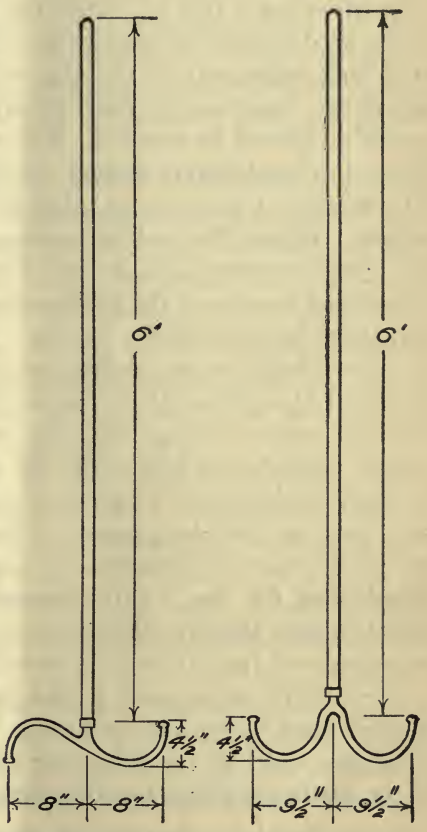

FIG. 8.—Two styles of cattle-dipping forks.

Men with dipping forks should be stationed along the vat to duck the heads of the animals and render assistance in case any of them become strangled. The two styles of dipping forks shown in figure 8 are the ones commonly used. They may be bought ready-made or may be made to order by the blacksmith.

After the cattle leave the vat they should be held in the draining pens or corrals until all surplus dip has drained off them. They should not be driven long distances or moved rapidly within 24 hours or even longer after dipping, as injury may result from too

much exercise or overheating shortly after dipping, especially if arsenical dip or oil is used.

The dip in the vat should be changed as soon as it becomes filthy, regardless of the number of animals that may have been dipped in it. In cleaning the vat the entire contents should be removed, including all sediment and foreign matter.

DIPS FOR CATTLE LICE.

In choosing a dip for cattle lice the conditions under which it is to be used should be considered. If the dipping plant is supplied with soft water, any of the dips recommended for lice may be used; but if the water is very hard the dip that mixes best with the water available should be selected. The arsenical dip mixes well and may be used in hard waters without injury to the animals from that cause. The nicotin dips also are suitable for use in any reasonably good water. While the coal-tar creosote dips when used in soft water are very effective against lice, they sometimes injure the animals when used in some of the hard waters. Before using coal-tar creosote dips with hard or alkaline water the following test should be made to learn whether a separation occurs in such water: In a clean bottle or jar of clear glass place a measured quantity of dip and pour in, with thorough mixing, the desired quantity of water, preferably warm, which should be added in approximately the proportion to be used in dipping. If after standing for one hour an oily layer or a mass of globules appears either at the top or at the bottom of the liquid, the dip should not be used with that kind of water. This simple test for the coal-tar creosote dips may often prevent loss. Death losses, however, may occur even when there is no apparent separation of the diluted dip tested by this method.

None of the dips tried in the bureau's investigations can be depended upon to eradicate all cattle lice with one dipping, but any of those described in the following pages will generally eradicate lice if the cattle are given two dippings 15 to 16 days apart.

ARSENICAL DIPS.

Arsenical dip has been used to a considerable extent for lice and it has proved to be a very satisfactory remedy. The formula for making 500 gallons of arsenical dip is as follows.[1]

4 pounds caustic soda (85 per cent pure).
8 pounds white arsenic (99 per cent pure), in fine powder.
8 pounds sal soda crystals.
1 gallon pine tar.
Water sufficient to make 500 gallons.

[1] For fuller information relative to arsenical dip see Farmers' Bulletin No. 603.

Place the caustic soda in a clean iron tank, tub, or pail, add 1 gallon of cold water, and stir until the caustic soda is dissolved. Then begin adding the arsenic, a pound or two at a time, as fast as it can be dissolved without causing the solution to boil, stirring all the time. If the liquid begins to boil stop stirring and let it cool slightly before adding more arsenic. The secret of success is to add the arsenic fast enough to keep the solution very hot, but not quite at the boiling point. The result should be a clear solution except for the dirt. If the liquid is muddy or milky add 1 gallon of water and stir, and if it does not clear up place the container over a fire and heat nearly but not quite to boiling and stir. As soon as the solution of arsenic is complete, dilute to about 4 gallons, add the sal soda, and stir until dissolved. After the solution has become cold add water to make it exactly 5 gallons.

Emulsify the pine tar as follows: Dissolve three-fourths of a pound of dry caustic soda or concentrated lye (or 1 pound of dry caustic potash) in 1 quart of water, add 1 gallon of pine tar, and stir until the mixture brightens to a uniform thick fluid somewhat resembling molasses. Test it by letting about a spoonful drip from the stirring paddle into a glass of water. It should mix perfectly with the water. If globules appear which can not be blended with the water by repeated stirring add more dissolved caustic soda, a little at a time, until the desired effect is produced.

The arsenical stock solution and the emulsified tar prepared as directed are sufficient to make 500 gallons of dip. Therefore, 1 gallon of the arsenic stock and about 1 quart of the tar stock added to approximately 99 gallons of water makes 100 gallons of dip. The quantity of stock solution prepared at any one time is limited only by the capacity of the available containers, but the proportion of the ingredients should not be altered.

Before adding the arsenic and tar stock to the bath fill that part of the vat below the dip line about three-fourths full of water. Then dilute the emulsified tar with about two or three times its volume of water and add it to the water in the vat, taking care to pour it evenly over the entire surface of the water throughout the length of the swim. Add the arsenical solution in the same manner; then add sufficient water to bring the liquid in the vat up to the dip line, stirring thoroughly.

Manufacturers have placed on the market several brands of ready-prepared arsenical dips, and any of these, if permitted by the Government for use in dipping cattle for southern fever ticks, are suitable for dipping cattle for lice.

In preparing and using arsenical dip it should be remembered that arsenic is a poison, and due precaution should be taken to avoid

injury. However, when it is handled and used with proper care it is a safe and efficacious remedy. The arsenic, as well as the other ingredients, should be weighed carefully. While the arsenical solution is being prepared care should be taken not to inhale the powder or the vapor given off, and the operator should stand on the windward side of the kettle as far away as possible. Care should be taken not to expose, more than necessary, the hands or other parts of the body to the action of the dip. The hands should be washed frequently and care taken not to get the clothing wet with the dip.

If animals are allowed to drain where pools of dip collect from which they may drink, or if they are turned into feed lots or pastures while the dip is dripping from their bodies so that the feed may become soiled, losses are liable to occur.

The arsenical dip left in the vat may be used again if it is not filthy. When not in use the vat should be covered or inclosed by a fence so that animals may not have access to it. In cleaning the vat the contents should not be emptied or allowed to flow into streams or on land or vegetation to which animals have access. The best plan is to run the dip into a pit or trench constructed for that purpose and protected by fences. The trench should be located so the dip will not be carried by seepage into the water supply of the farm or the neighborhood.

Although the arsenical dip is commonly used cold, it should not be cold enough to chill the animals. The temperature should range between 65° and 90° F.

COAL-TAR CREOSOTE DIPS.

The coal-tar creosote dips are sold under many trade names. They are made from coal-tar derivatives and the principal ingredient is creosote oil, which is made soluble in or miscible with water by means of soap. When diluted with soft water they are efficacious in eradicating cattle lice. Before using them with hard or alkaline water the test described on page 14 should be made. There is no field test for determining the deterioration of these dips, consequently in replenishing the dip the percentage of active ingredients in the vat is largely a matter of guesswork. Coal-tar creosote dips may be used cold or warm, but the temperature of the bath should not exceed 95° F.

These dips should contain, when diluted ready for use, not less than 1 per cent by weight of coal-tar oils and cresylic acid. In no case should the diluted dip contain more than four-tenths of 1 per cent nor less than one-tenth of 1 per cent of cresylic acid; but when the proportion of cresylic acid falls below two-tenths of 1 per cent the coal-tar oils should be increased sufficiently to bring the total of

the tar oils and the cresylic acid in the diluted dip up to 1.2 per cent by weight.

In the undiluted coal-tar creosote dips, especially in cold weather, a separation of naphthalene and other constituents of the dip may occur. Care, therefore, should be taken to see that the dip is homogeneous in character before using any portion of it.

The coal-tar creosote dips should be used in accordance with the instructions printed on the label of the container.

NICOTIN DIPS.

The nicotin dips are sold under various trade names, and farmers and live-stock growers are more or less familiar with them from using them as dips for animals and as insecticides for insect pests of plants. They are efficacious remedies for cattle lice when diluted with water so that the solution contains not less than five one-hundredths of 1 per cent of nicotin. If used much stronger than 0.05 per cent they are liable to injure cattle, especially if the animals are dipped while they are hot, but if properly used they cause no injury. A field test has been designed by one of the large manufacturers of nicotin dips so the percentage of nicotin in the dipping bath may be ascertained at the vat side at any time. Nicotin dips should be used in accordance with the instructions printed on the label of the container. Do not use any preparation the strength of which is not given on the label.

Nicotin dips usually are used warm, but should not be heated above 110° F. During dipping operations for lice the temperature of the dip should be maintained at 90° to 95° F.

Sulphur is sometimes added to nicotin dips in the proportion of 16 pounds flowers of sulphur to 100 gallons of diluted dip. Very little of the sulphur is dissolved in the dip, but a part of it remains in suspension in the bath during dipping and becomes lodged on the skin of the animal, where it remains for a long time, thus tending to prevent reinfestation.

DIPPING PLANTS.

The farmer who has but a small number of animals to dip may use a portable galvanized metal vat (fig. 9). These vats may be purchased ready-made, and they will answer the purpose very well for dipping small lots of light or medium weight cattle. After digging a trench and setting the vat so that the top is flush with the surface of the ground, a chute and a slide board should be provided as a means of getting the animals into the vat.

A permanent dipping plant is much more satisfactory, and where there are a number of farmers in a community who want to dip their

cattle a good plan is for each to contribute in proportion to the number of cattle owned and use the fund for building a community dipping plant. In designing or selecting a plan for a dipping plant it is well to remember that the vat should be constructed so as to be suitable for use in dipping for scab as well as for lice and other parasites.

Two styles of dipping plants are shown in the plans (figs. 10 and 11). Either of these is suitable for dipping cattle or horses for any purpose. The chutes, draining pens, etc., shown in one set of plans may be substituted if desired for those shown in the other.

If a dip is to be used which requires cooking and settling, such as homemade lime-sulphur, commonly employed in the treatment of scab, it is necessary to provide boiling and settling tanks (fig. 12).

SELECTING A LOCATION.

In selecting a location for a dipping plant the fact that animals work better up grade should be considered, and the corrals and running chute should slope up to the entrance end of the vat. The vat should be on level ground, preferably extending north and south

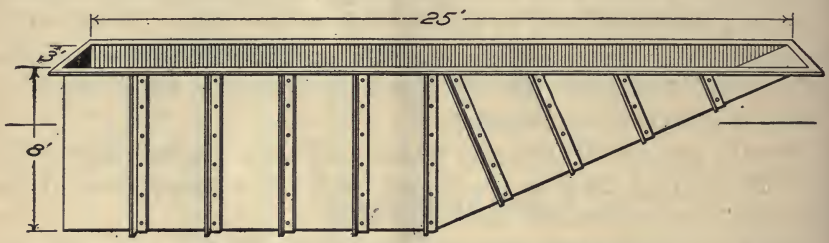

FIG. 9.—Portable galvanized metal dipping vat.

with the entrance at the south and the exit at the north, as it has been observed that animals work better when not facing the sun. A considerable quantity of water is used in dipping, so the dipping plant should be located close to an adequate supply. The vat, however, should not be located on low, marshy land or where flood waters overflow.

CORRALS AND CHUTES.

The receiving corrals, into which the animals are driven preparatory to dipping, as well as the holding corrals, into which they go from the draining pens, should each be large enough to hold the largest herd to be dipped. They should be constructed so that there may be the least possible number of corners in which the cattle may become crowded and injured.

The proper design and construction of the chutes is important, because improperly constructed chutes add greatly to the difficulty

of getting cattle into the vat and often cause rough handling of the animals. The running chute should be at least 30 feet long and

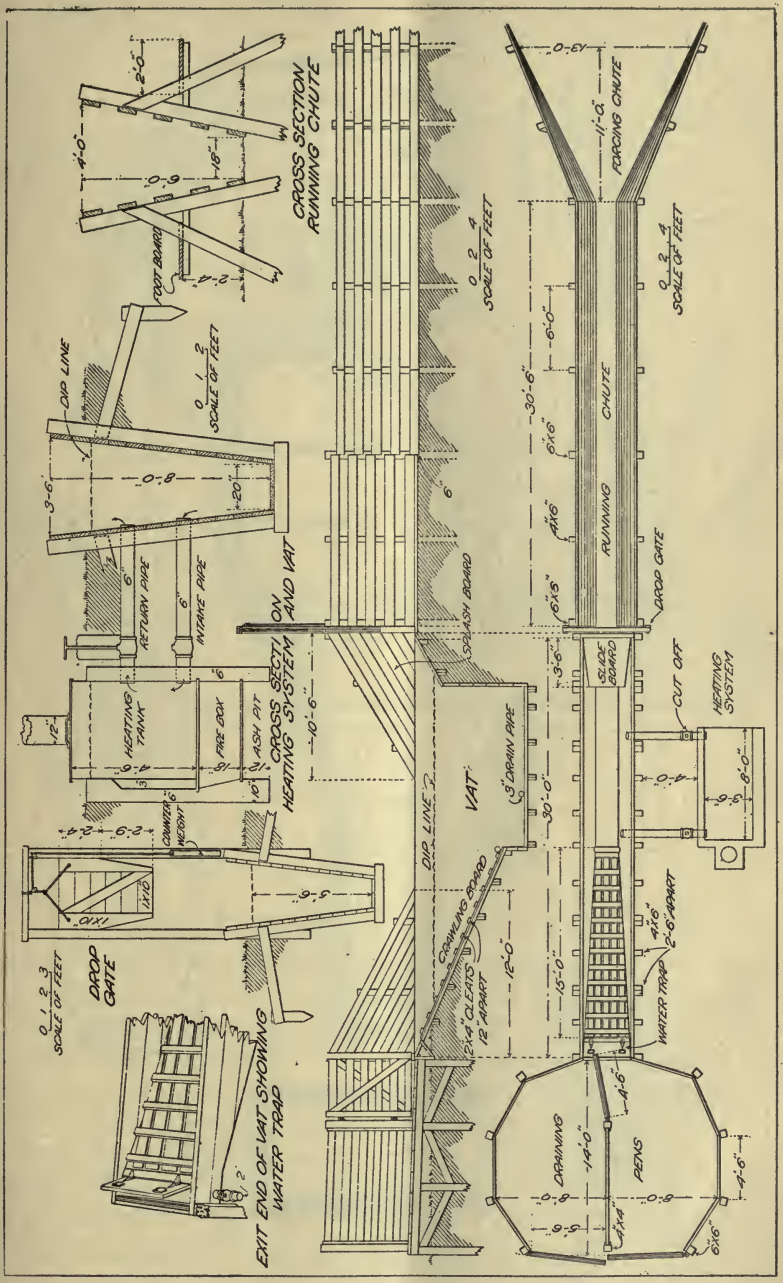

Fig. 10.—Plan of cattle-dipping plant with wooden vat.

preferably curved to obstruct the view of animals approaching the vat. Two styles of running chutes and crowding chutes are shown in

the plans, and dimensions and structural details are given. Two styles of chute gates are also shown. Most stockmen probably will

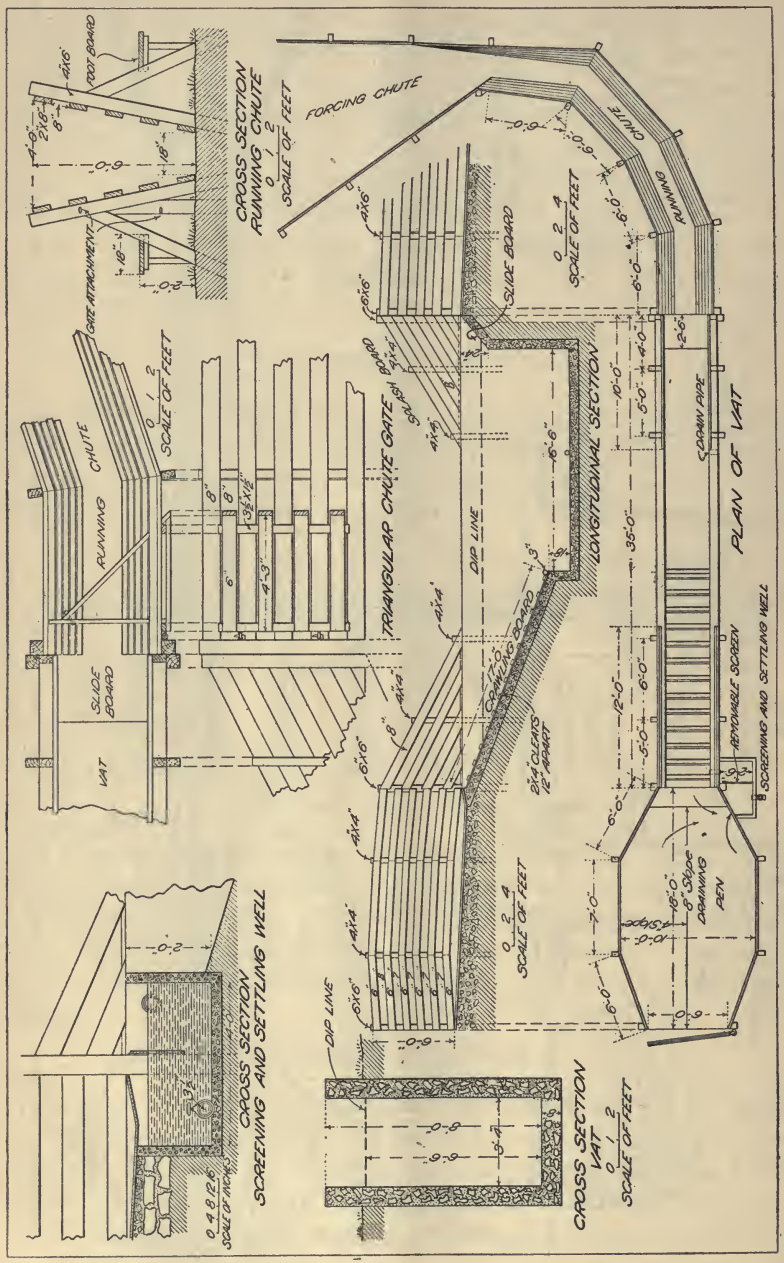

Fig. 11.—Plan of cattle-dipping plant with concrete vat.

prefer the triangular gate. A drop gate like that shown in figure 10 may be adapted for use either as a check gate in the chute or as

a holding gate in the vat. A holding gate in the vat located at the beginning of the exit incline is necessary only in case animals are to be dipped for scab, or when it is desirable that they be held in the dip longer than the time ordinarily required for passing through the vat.

DRAINING PENS.

When cattle emerge from the vat they carry out some of the dip, which runs off their bodies very rapidly. This dip should be saved

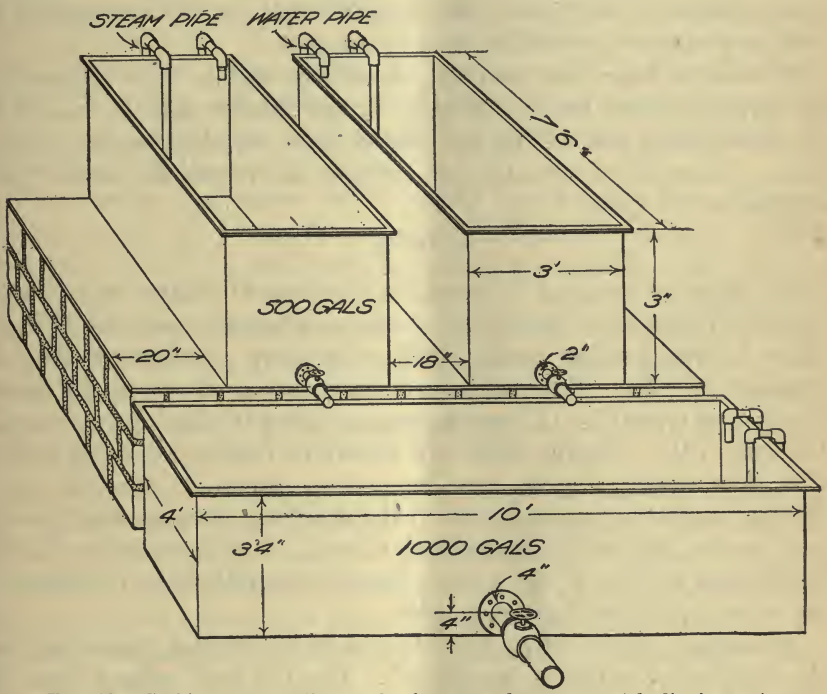

FIG. 12.—Cooking and settling tanks for general-purpose cattle-dipping vats.

and returned to the vat, not only because it may be used over and over again, but because if it is allowed to drip off in the holding corrals pools of dip collect from which the animals may drink with possibly injurious results, and even if no cattle are poisoned in this way the mud holes which form in the corrals are highly objectionable. Draining pens with water-tight floors sloping toward the vat or draining wells should be provided to catch and return the dip to the vat. The size shown in the plans may be increased or decreased to correspond to the length of the vat. The floors of the pens may be made of lumber or cement and should have settling wells or water traps to prevent rain water from running into the vat and diluting the dip. A design of a settling well is shown in connection with the

cement vat and one of a water trap with the wooden vat. The settling well may be used with the wooden vat, in which case the water trap would be unnecessary, as the settling well serves the same purpose.

In constructing the draining pens of cement it is advisable to build the outer walls in the same manner as the foundations for a house, except that they are to be 8 inches thick. The space inside the walls is then filled with gravel to the required height and the sloping floors laid on the tamped gravel. To prevent slipping the cement floors should be roughened with a stiff broom while the concrete is soft, or a coat of pebble dash may be applied.

If wooden floors are used they should be double with a layer of tar paper between the two floors. Rough lumber may be used for the lower floor, but the top one should be of matched boards 1 inch thick. Cleats should be nailed on the floor to prevent the cattle from slipping.

VATS.

The dipping vat may be constructed either of cement or of lumber—the cement vat being preferable, as when properly made it is more durable and in many other ways more satisfactory than a wooden vat. The sides may be perpendicular, as shown in the plans for a cement vat (fig. 11), or sloping, as shown in those for a wooden vat (fig. 10). Sloping sides are generally considered more desirable than perpendicular ones for either cement or wooden vats. Both styles, however, are shown in the drawings, because some stockmen prefer vats with perpendicular sides. The dimensions shown in the cross section of the wooden vat may be followed in constructing a cement vat with sloping sides.

The length of the vat may vary from 24 to 100 feet, depending on the number of cattle to be dipped. The top may extend 9 to 18 inches above the surface of the ground or may be flush with it. A vat of the former kind affords better conditions for handling the cattle than one of the latter kind. If it is desired that the top be flush with the ground, the vat should be built so it extends 5 inches above the natural surface of the ground, which is then graded up with gravel or cinders and a dry path along each side of the vat thus provided.

The slide board should be made of or covered with a smooth-surfaced material, such as planed lumber or sheet metal. A piece of boiler plate makes an excellent slide board. The dimensions of the slide board shown in connection with the cement vat are those commonly used. A short, steep slide board causes the animals to plunge abruptly into the dip, while a long gradual slope allows them to slide in more gently. The short, steep slope has the advantage

that the animals can not brace themselves on it for a leap as easily as on the long, gradual slide.

The exit incline or crawling board in small vats should be about 16 feet long, so that the incline may not be too steep. In cement vats a false floor to which the cross cleats are nailed is usually laid on the exit incline. Bolts should be embedded in the concrete for fastening the false floor. The plans for the concrete vat show the lower end of the floor held in position by a cross pipe embedded in the concrete and the upper end and middle held by bolts.

If permanent pipes are used for conducting water and dip to the vat they should be laid so as not to act as obstacles to the men working along the vat. There should be no obstruction in the path along both sides of the vat; neither should there be any cross pieces over the top of the vat that may interfere with the proper handling of the cattle while they are in the dip.

The wooden vat shown in the plans has sloping sides, but, as already stated, they may be made perpendicular if desired. When soft wood is used for the frame timbers they should be 6 by 6 inches, but if hard wood is used 4 by 4 inch timbers are sufficiently large for the purpose. Cedar posts make good framing timbers, as they do not rot rapidly. Matched planks 2 inches thick should be used in building the vat, and they should be beveled so that all joints and seams may be properly caulked with oakum and rosin or similar material.

A water trap with hinged cover is shown in the exit incline of the wooden vat. While dipping is in progress both the cover and the valve to the drain pipe should be closed, but when dipping is finished for the day both should be opened so that water from the draining pens in case of rain may not run into the vat and dilute the dip.

Heating equipment is necessary in the case of those dips which are used warm. That shown in the plans of the wooden vat may also be built in connection with a cement vat. When the open-tank heating system shown in the plans is used settling wells are not necessary, as the heating tank answers the purpose of a settling well. This system has an advantage over the old-style coil heater in that the pipes may easily be kept from clogging. Another method of heating, and the one usually employed, is to install a 25-horsepower boiler and to pipe the steam to the vat, where it discharges into the dip through perforations in a pipe laid along the bottom of the vat for about two-thirds its length. The water condensing from the steam passing into the vat from the boiler dilutes the dip to a slight extent, and for this dilution an allowance should be made in replenishing the dip.

The trench for the vat should be excavated so that the inside dimensions correspond with the outside dimensions of the com-

pleted vat. If the sides of the trench are reasonably firm they may be used for the outer walls of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the ground surface to the top of the vat. If the soil is sandy or the walls cave in it will be necessary to use outer forms, in which case the trench should be wide enough to allow for these forms.

The forms usually are made of 1-inch boards and 2 by 4 inch braces, but as a supply of 2-inch lumber is necessary for the corrals and chutes, some of this lumber may first be used for the forms and

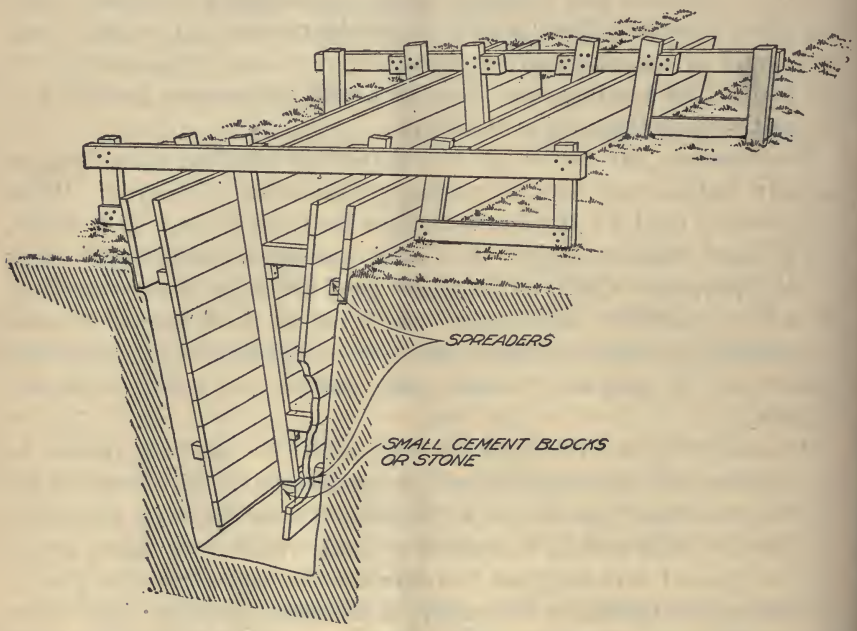

FIG. 13.—Section of trench for concrete vat with sloping sides, showing the forms in place and one method of bracing. (Compare with fig. 14.)

afterwards for constructing corrals and chutes. Two methods of bracing the forms are illustrated (figs. 13 and 14).

Bolts for fastening the crawling and slide boards and the drain and other pipes should be placed in position in the forms before the concrete is laid. The concrete side and end walls may be reinforced with heavy woven wire, in which case the reinforcements should be placed properly in the forms so that they may be embedded in the middle of the walls.

The concrete for dipping vats should be made of 1 part of Portland cement by measure, 2½ parts of sand, and 4 parts of screened gravel or crushed stone. The sand should be coarse, clean, and free from foreign matter. The crushed stone or gravel may vary in size

from one-quarter to 1 inch in diameter. The mixing should be done on a smooth, tight, platform and the sand and rock measured separately in a bottomless box 2 feet long, 2 feet wide, and 1 foot deep, having a capacity of 4 cubic feet. For $2\frac{1}{2}$ cubic feet mark the inside of the box $7\frac{1}{2}$ inches up from the bottom. Each sack of Portland cement is considered equal to 1 cubic foot. Mix thoroughly the sand and cement, add the crushed stone (previously drenched with water), and mix the whole mass by turning it several times with shovels. Then add water in a depression made in the center of the pile and mix well by turning several times with shovels, adding sufficient water during the mixing to make a quaky or thin jellylike mixture.

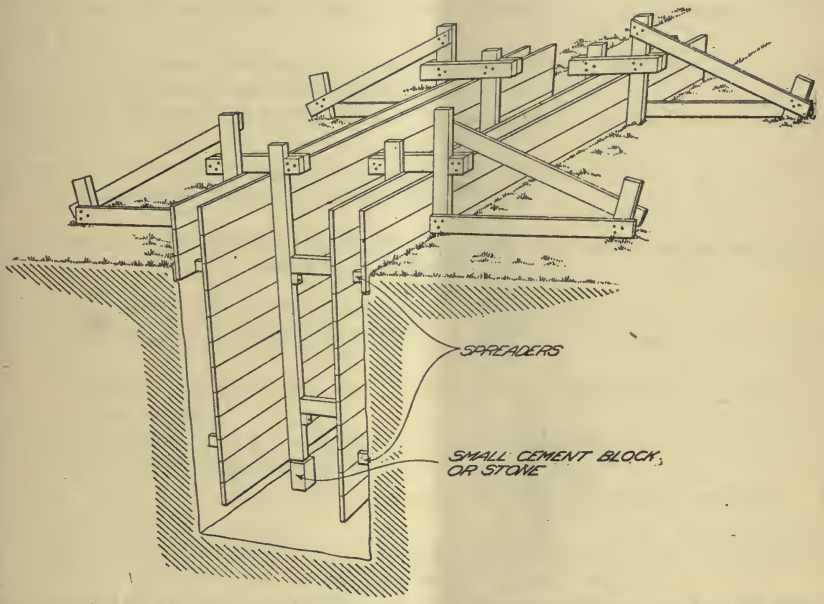

FIG. 14.—Section of trench for concrete vat with perpendicular sides, showing the forms in place and another method of bracing. (Compare with fig. 13.)

The placing of the concrete in the forms should be commenced as soon as the mixing is finished. The floor and exit end should be laid first and the concrete well tamped. In filling the forms the concrete should be settled into place by spading rather than tamping, and special attention should be given to spading next to the inside forms to force back the coarse particles and allow the sand-cement mortar to form a dense, water-tight surface. An old hoe straightened out makes a good spading tool, as the handle is long enough so that the bottom of the forms may be reached. If it is necessary to stop work for the day before the forms are filled, the surface of the concrete in the forms should be roughened with a stick. Just before placing additional concrete wash the roughened

surface and paint it with cement and water mixed to the consistency of thick cream. Leave the forms in place two or three days, if possible, and wet the concrete daily. After the forms are removed, dampen the surface of the concrete and apply a finishing coat composed of 1 part of cement and 2 parts of sand, or mix cement and water to the consistency of cream and apply it, brushing well to form a smooth surface.

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Texas or Tick Fever. (Farmers' Bulletin 569.)
Arsenical Cattle Dips. (Farmers' Bulletin 603.)
Eradication of Cattle Tick Necessary for Profitable Dairying. (Farmers' Bulletin 639.)
Repellents for Protecting Animals from Attacks of Flies. (Department Bulletin 131.)
Effect of the Cattle Tick Upon Milk Production of Dairy Cows. (Department Bulletin 147.)
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Methods of Eradicating Cattle Ticks. (Bureau of Animal Industry Circular 110.)
Directions for Constructing Vats and Dipping Cattle to Destroy Ticks. (Bureau of Animal Industry Circular 207.)

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Scabies of Cattle. (Farmers' Bulletin 152.) Price 5 cents.
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Special Report on the Disease of Cattle. Price $1.00.

GAME LAWS FOR 1917

A SUMMARY OF THE PROVISIONS OF FEDERAL, STATE, AND PROVINCIAL STATUTES

GEORGE A. LAWYER, W. F. BANCROFT, and FRANK L. EARNSHAW
Assistants, Bureau of Biological Survey

FARMERS' BULLETIN 910

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief

Washington, D. C. October, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

THE objects of this bulletin, containing the eighteenth annual summary of the game laws, are to present in convenient form for sportsmen and others the hunting laws and regulations of the Federal, State, and Provincial Governments, and to show the general condition and trend of game legislation from year to year. Provisions relating to methods of capture, game refuges, enforcement of laws, disposition of fines and fees, and matters of minor importance are omitted. These can be found only by reference to the laws themselves or to pamphlet editions of the game laws, obtainable in most of the States from proper officials.

The bulletin has been prepared on a plan considerably different from those heretofore issued (1902–1916). Provisions relating to seasons, licenses, limits, possession, sale, and export, and a few miscellaneous provisions have been compiled and grouped under States alphabetically arranged, thereby enabling sportsmen and others interested to secure conveniently a brief synopsis of the laws of the State or Province in which they are particularly interested.

GAME LAWS FOR 1917.

A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES.

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REVIEW OF LEGISLATION OF 1917.

IN VOLUME and number of laws the record of game legislation of 1917 is probably equal to that of any previous year except 1911. Legislative sessions were held in 43 States, and in all but 5 of these more or less extensive changes were made in the game laws.[1] Several States codified or revised their game laws, and a very general effort was made to bring the open seasons for migratory birds into conformity with the Federal regulations. A number of seasons were shortened, and in some States birds which have become greatly reduced in numbers were temporarily removed from the game list by providing close seasons for several years. Unusual progress was made in establishing State game preserves, and the propagation of game was encouraged by several important amendments.

BIG GAME.

Changes affecting big game were nearly all in the direction of greater protection. The season on deer was closed in Oklahoma for five years and in Utah for three years. The killing of does was prohibited in Arkansas and Saskatchewan, and in Mississippi, through

[1] About 250 separate laws relating to game were passed exclusive of appropriation and bounty acts. The highest number in any previous year was in 1911, when about 275 were enacted. Alabama, Kentucky, Louisiana, Mississippi, and Virginia held no regular sessions, and no game legislation was enacted in Georgia, Indiana, New Mexico, or West Virginia.

the rejection of the game law of 1916, the old law protecting female deer was left in force. On the other hand, protection was removed from does in Idaho and Wisconsin. As a result of these changes does are now protected in 14 of the 32 States in which deer hunting is open this year, in Alaska, and in 4 Canadian Provinces.[1] The deer laws were made more liberal in California by permitting hunting deer with one dog and allowing a deer killed in a closed district to be shipped into an open district, and in Colorado by providing an open season of four days to begin in 1918. The limit on elk has been reduced from two to one is Saskatchewan. Much-needed protection was given antelope in Nevada and Texas, and seasons extended on these and other big game in Colorado, Montana, and Texas. Alberta extended the close season on antelope to 1925. Buffalo and elk were protected at all seasons in North Carolina, elk in Manitoba, and female sheep and lambs in Alaska.

MIGRATORY BIRDS.

The treaty with Great Britain for the protection of migratory birds in the United States and Canada was ratified August 29, 1916, and ratifications were exchanged December 7, 1916. Early in the present year a bill to carry the treaty into effect was introduced in Congress, but too late in the session to permit consideration before adjournment on March 4. When the Sixty-fifth Congress convened identical bills (H. R. 2612 and S. 1553) were introduced in the House and Senate on April 10 to carry the treaty into effect. The Senate bill was passed on July 30, and is now awaiting consideration in the House. In Canada a similar measure passed both Houses of Parliament and became a law August 29.[2]

A very general effort has been made on the part of the States to conform their laws with the Federal regulations, and on the part of the Canadian Provinces to bring their laws into harmony with the provisions of the treaty. In 21 States the open seasons on waterfowl were made uniform and seasons on other birds were brought into practical harmony with the Federal regulations. The most important of these changes were made in Arkansas, Colorado, Nebraska, Oklahoma, South Dakota, and Tennessee, where spring shooting of waterfowl and shore birds, formerly permitted, is now entirely prohibited.

[1] Does are protected throughout the year and hunting restricted to bucks in Alabama, Arizona, Arkansas, California, Mississippi, Missouri, New Jersey, New Mexico, New York, Oregon, Pennsylvania, Texas, Vermont, West Virginia, and Alaska; and also in Alberta, Manitoba, Nova Scotia, and Saskatchewan.

[2] See p. 67.

CLOSE SEASONS ON GAME BIRDS.

Protection throughout the year has been afforded certain species of birds which have become greatly reduced in numbers. The sage grouse has been protected for several years in Idaho, New Mexico, Nevada, Utah, and in District 4 in California, over an area including nearly half of the present range of the species. Quail have been protected for several years in Idaho, Iowa, Nebraska, and Ohio; prairie chickens in Idaho, Iowa, and Oklahoma; wild turkeys in Oklahoma; doves and plover in Nebraska; and all shore birds, except jacksnipe, in California.

CODIFICATIONS OF GAME LAWS.

An important matter in these days of complicated game legislation, when laws are amended at nearly every session and scattered through several volumes of the statutes, is to simplify them as far as possible by revision or codification so as to bring them together, eliminate conflicting provisions, and simplify the wording. Important progress in this direction has been made this year in at least six States: Maine, Pennsylvania, and Wisconsin have codified their entire game laws; New Hampshire and Utah have revised their statutes; and Minnesota has appointed a commission to prepare a codification of the game laws.

ADMINISTRATION.

Of several radical changes made in administration of the laws probably the most important is the establishment of a department of game and fish in Nevada. In Illinois, the game and fish commission, established in 1915, was abolished and the work placed under the department of agriculture with a chief game and fish warden in direct charge. In Maine a single commissioner of inland fisheries and game has been substituted for the commission of three members which has been in charge of the work since 1899. In Mississippi the law enacted last year creating the department of game and fish, and placing the work in charge of a commissioner, was submitted to the voters under a referendum petition and rejected at the general election in November, 1916, thus leaving the State without any general officer in charge of game matters. In New Jersey the board of fish and game commissioners has been increased from four to seven members. In Pennsylvania the provision requiring game protectors to enforce the fish and forestry laws as well as the game laws was strengthened and made more explicit. The salary of the commissioner of inland fisheries and game in Maine was increased to $2,500, that of the State warden of South Dakota to $2,400, and that

of the chief protector of New York to $5,000 per annum. In Florida the county warden system was reestablished in conformity with the decision declaring the law of 1915 unconstitutional.

GAME REFUGES AND PRESERVES.

Unusual interest has been manifested in the establishment of new game preserves, particularly in the West, and more legislation on this subject has been enacted than in any previous year. The list of new reservations includes the national park known as the Mount McKinley National Park in Alaska, with an area of 2,200 square miles, created by act of Congress on February 26, 1917; 40 State game preserves established by acts of the legislatures; an additional game farm in New York in connection with Cornell University; several new preserves in Minnesota established by the game commissioner under authority of existing law; and provision for auxiliary State game preserves in Pennsylvania.

New State preserves are distributed in 10 States—16 in California, 6 each in Montana and Wyoming, 4 in Arizona, 3 in Idaho, and 1 each in Oklahoma, Oregon, Tennessee, Washington, and Wisconsin. More than three-fourths of the entire number are located on national forests. California's 16 new refuges are scattered throughout the Sierras and the Coast Range, the smallest on the Klamath River, with an area of 8,960 acres, the largest on the headwaters of the Sespe River in Ventura County, with 125,440 acres, including in all 811,180 acres; these additions make a total of more than a million and a half acres in game refuges in the State. The six refuges in Montana are the Snowy Mountain, on the Jefferson National Forest; Highwood National Forest Reserve; the Twin Buttes Game Preserve, on the Lewis and Clark National Forest; the Powder River Game Preserve, in Custer County; the South Moccasin Mountain Game Preserve, in Fergus County; and the Flathead Lake Bird Preserve, comprising two islands in Flathead Lake. The six new game preserves in Wyoming are known as the Carter Mountain, Days River, Wind River, Careyhurst, Bridger, and Kendall State Game Preserves; eliminations were also made in the eastern part of the Teton Preserve and in the Bighorn Preserve. The four Arizona preserves are in the southern part of the State, two on the Crook National Forest, one on the Apache National Forest, and one on the Coronado National Forest. Idaho established the Big Creek Preserve, in Lemhi County; the Big Lost River Game Preserve, in Blaine and Custer Counties, and the Selway Game Preserve, on the boundary between Idaho and Montana. Oklahoma reappropriated $94,197.10 (the amount borrowed from the game fund several years ago) for the purchase of a State game preserve. Oregon established a refuge for ringnecked pheasants, grouse, quail, and Hungarian par-

tridges along the lower Willamette River, in western Multnomah and northwestern Clackamas Counties. Tennessee ratified the action of the State warden in creating the Appalachian Fish and Game Preserve No. 1, comprising the counties of Sevier, Blount, Monroe, and Polk. Washington established a refuge of 27,280 acres in Okanogan County; Wisconsin a preserve in Forest County; and Kansas accepted the cession of the lands granted by Congress in 1916 for a game preserve.

In Canada, Manitoba has established two new preserves, the Bird Island Preserve, of 57 sections, and a large refuge known as the Lake Winnipegosis, comprising 587 sections, and has eliminated small areas in the southern parts of the Rising Mountain and Red Deer Point Preserves.

NOVEL LEGISLATION.

Several new features in game protection have been introduced during the year. The first game law placed on the statute books of any State through the medium of an initiative petition was adopted in Arizona at the general election in November, 1916. Hunting game with flying machines has been made illegal in North Carolina by a law prohibiting shooting waterfowl on any of the waters of the State from an airplane. Cat-license bills introduced in Massachusetts, New York, New Jersey, and elsewhere seem to have failed uniformly, but in two States brief cat laws were passed. Massachusetts passed a law prohibiting possession of cats on Muskegat Island or the bringing of any cats to the island, and Michigan declared cats following on the track of game birds or small game public nuisances and decreed that the owner who permits them to run at large after notice from the game commissioner shall be deemed guilty of a misdemeanor. Plumage legislation has been extended in at least two States. Oklahoma now prohibits possession for sale of aigrettes and California of aigrettes, birds of paradise, goura pigeons, and numidi.

Administration of game laws has been modified in several important details. Oklahoma has a fixed penalty for any offense for which no specific penalty is otherwise provided, thus guarding against a condition which sometimes arises whereby a certain act is made an offense without a penalty, and the law consequently is unenforceable. Oregon has authorized the board of fish and game commissioners to permit under such regulations as it may adopt the sale of any game which can not otherwise be sold. Pennsylvania has imposed, as a penalty for conviction for a second offense under the game law, imprisonment equal to one day for each dollar of the

fine and denial of license to hunt for two years. Utah has passed a law prohibiting aliens from hunting in the State. Wisconsin has extended its provision relative to seizure of paraphernalia used in violation of the game law to include automobiles, which, when used by persons hunting illegally, may be confiscated by conservation officers. The law in New Hampshire authorizing the payment of damages for injuries to live stock caused by persons hunting deer has been modified so that in future such damages will be assessed by the commissioner of agriculture and paid from the fish and game fund.

Several measures affecting private game preserves merit mention. Texas exempted from taxation buffalo and catalo kept in captivity, while Oklahoma exempted not only buffalo but also deer, elk, and antelope. In South Carolina a specific tax on game preserves was imposed on all holdings in excess of 5,000 acres, except in Berkeley County, the rate of taxation being 2 cents an acre for tracts of 5,000 to 30,000 acres, 4 cents from 30,000 to 55,000 acres, and 5 cents for larger tracts. In two States there has been a manifest effort to extend the scope of work of the State warden beyond the field of actual game protection to cooperation in certain public improvements. Wyoming has provided for the establishment of zoological gardens in cities and towns and authorized the game commission to supply birds and animals for the collections, while Iowa has authorized the State warden, with the consent of the executive council, to establish public parks on the shores of lakes, streams, or other waters of historic or scientific interest and has provided a $50,000 annual appropriation from the fish and game fund for the improvement of such parks on condition that this amount does not exceed one-half of the total receipts of the fund.

An unusual number of bills failed this year after being passed by the legislature. In Florida and in Illinois the general game bills were vetoed by the governor on grounds of unconstitutionality. In Kansas a bill to extend the close season on certain upland game birds was amended in the senate so as to open the season on quail for two weeks in December, and this bill with the amendment was published in the session laws. It appears, however, that the senate amendment was not adopted in conference, and the bill as actually passed by the legislature was not published in the statutes and, in the opinion of the attorney general, is not in effect. This leaves the law of 1913 still in force. In Pennsylvania a bill providing for the payment of bounties was vetoed by the governor, and in Washington a provision in the game law defining the hours of sunset in connection with hunting migratory waterfowl was likewise vetoed.

SUMMARY OF LAWS RELATING TO SEASONS, LICENSES, LIMITS, SALE, AND EXPORT.

The open seasons for migratory game birds appear under the respective States and Provinces. The seasons shown are the times when migratory game birds may be hunted without violating either State laws or Federal regulations.[1] Federal regulations now prohibit shooting from sunset to sunrise. If proposed amendments of the regulations issued July 9, 1917, are finally adopted on or after October 15, whenever approved by the President, it will be lawful to hunt migratory game birds from half an hour before sunrise to sunset, subject, however, to State laws placing restrictions on hunting during that time.[2]

The Federal migratory-bird regulations prohibit throughout the United States the killing at any time of the following birds:

Band-tailed pigeon; little brown, sandhill, and whooping cranes; wood duck, swans; curlews, willet, upland plover, and all shore birds (except the black-bellied and golden plovers, Wilson snipe or jack-snipe, woodcock, and the greater and lesser yellowlegs); bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, hummingbirds, kinglets, martins, meadowlarks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwills, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects.

In some States certain days of the week constitute close seasons throughout the time in which killing is permitted. Hunting on Sundays is prohibited in all States and Provinces east of the one hundred and fifth meridian except Illinois, Louisiana, Michigan, Texas, Wisconsin, and Quebec. Mondays constitute a close season for waterfowl in Ohio, and locally in Maryland and North Carolina; and other week days for waterfowl in several favorite ducking grounds in Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Maryland in Allegany, Baltimore, Cecil, Charles, Frederick, and Harford Counties; and when snow is on the ground in New Jersey, Delaware, Virginia, and Maryland. The county laws of North Carolina, which are too numerous to be included satisfactorily, are not incorporated in the following summary, which otherwise may be regarded as a practically complete résumé of the regulations now in force.

The possession of all game is so generally prohibited during the close season as to render a detailed enumeration unnecessary; but

[1] The full text of the migratory-bird law and regulations will be found on pp. 59–64.
[2] This amendment was approved by the President, October 10, 1917.

when an extension of a few days is added to the open season or a special season is provided for either possession or sale, attention is called specially thereto.

In stating the open seasons[1] the plan of the New York law, to include *the first and the last days thereof*, has been followed. The difficulty of securing absolute accuracy in a statement of the seasons is very great, and the absence in the laws of many States of express legislation as to the inclusion or exclusion of the date upon which seasons open and close makes exactness almost an impossibility.

The open seasons shown in the tables *include both dates.* Seasons which apply only to special counties are placed to the left of the column containing those for the State in general. Species (except migratory birds protected throughout each year by Federal regulation) on which the season is closed for a term of years or an indefinite period are grouped under the term "No open season." Provisions of State laws prohibiting hunting at night, between sunset and sunrise, or during certain hours, are not included.

Persons are advised to secure from State game commissioners[2] full text of game laws in States where hunting is contemplated.

ALABAMA.

Open seasons:

Deer (male)	Nov. 1–Jan. 1.
Squirrel (black, gray, fox)	May 15–June 15. Aug. 1–Jan. 1.
Quail (partridge)	Nov. 1–Mar. 1.
Ruffed grouse (pheasant), introduced pheasant, or other introduced game birds	Nov. 15–Dec. 15.
Wild turkey gobblers	Dec. 1–Apr. 1.
Dove	Aug. 1–Mar. 1.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, coot, mud hen	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail	Sept. 1–Nov. 30.

No open season: Does, elk (1925); hen turkeys.

Hunting licenses: Nonresident or alien, $15. Resident: State, $3; county, $1. Issued by probate judges. Landlords, tenants, and members of families may hunt on own land without license. Written permission required for hunting on land of another.

Bag limits and possession: One deer, 10 squirrels, 2 turkey gobblers, 25 of each other kind of game bird a day. Possession of game permitted during open season and first 5 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except that a nonresident licensee may take with him, openly, game he has lawfully killed.

State game and fish commissioner may issue $1 permit to any person to capture or transport not more than 10 pairs of any one species of game birds for scientific or propagating purposes.

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[1] For open seasons on fur-bearing animals, see Farmers' Bulletin 911, 1917.

[2] See p. 70. A full list of names and addresses of officials and organizations concerned with the protection of birds and game will be found in Biological Survey Document 108, 1917.

ALASKA.

Open seasons: [1]

North of latitude 62°—

Moose (females and yearlings protected all the year), caribou, sheep, Aug. 1–Dec. 10.

South of latitude 62°—

Deer with horns 3 inches long (see exception)—Aug. 15–Oct. 31.

Exception: Deer on Duke, Gravina, Kodiak, Long, Kruzof, San Juan, Suemez, and Zarembo Islands, 1918; Hinchinbrook and Montague Islands, 1919.

Mountain goat in southeast Alaska and Kenai Peninsula, Aug. 1, 1918.

Moose (females and yearlings protected all the year), caribou, sheep (see exception)—Aug. 20–Dec. 31.

Exception: Moose, south Lynn Canal; caribou on Kenai Peninsula; sheep, Kenai Peninsula, east of long. 150°—Aug. 20, 1918.

Ewes and lambs on Kenai Peninsula and north of lat. 60° and west of long. 141°, 1919.

Brown bear—Oct. 1–July 1.

Throughout Territory—

Grouse, ptarmigan, shore birds, waterfowl—Nov. 1–Mar. 1.

Hunting licenses: Nonresident, $50; nonresident alien, $100. Guide, first-class, $25 (American citizen); second class, $7.50 (native of Alaska—fee fixed by governor).

Shipping licenses: Resident, $40 (export of heads or trophies); $10 (single trophy of caribou or sheep); $5 (single trophy of deer, goat, or brown bear). Special license for shipping one moose killed south of latitude 62°, $150.

(Not more than one general ($40) license and two special ($150) moose licenses issued to one person in one year. Each shipper must file with the customs office at port of shipment an affidavit that he has not violated the game law; that the trophy to be shipped has not been bought or purchased, has not been sold, and is not shipped for purpose of sale; that he is the owner of the trophy, and, in case of moose, whether the animal from which it was taken was killed north or south of latitude 62°.)

Bag limits: Three deer, 2 moose, 3 caribou, 3 sheep, and 3 brown bears a season; 25 grouse or ptarmigan, 25 shore birds or waterfowl a day or in possession.

Sale: Sale prohibited of heads, hides, and skins of all protected game; deer until August 1, 1918; moose and sheep south of latitude 62° and between longitude 141° and a line passing along western outlet of Lake Clark in longitude 155° until August, 1918.

Permitted: Carcasses of all game (except deer, moose, and sheep as above stated) may be sold during the open season and 15 days thereafter.

Export: Export prohibited of deer, moose, caribou, sheep, goat, bear, or hides of these animals; wild birds, except eagles, or any parts thereof: *Provided,* Specimens may be exported under restrictions imposed by the Secretary of Agriculture and trophies of big game under licenses issued by the governor. (See licenses.)

ARIZONA.

Open seasons:

Deer (male)—Oct. 1–Nov. 1.
Quail (except bobwhite)—Oct. 15–Dec. 31.
Wild turkey—Oct. 1–Nov. 1.
Dove and white wings—July 15–Dec. 31.
Duck, goose, brant, Wilson snipe, coot, gallinule—Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs—Oct. 15–Dec. 15.
Rail—Oct. 15–Nov. 30.

No open season: Does, spotted fawn, elk, antelope, sheep, goat, bobwhite, grouse, pheasant.

Hunting and fishing licenses: Nonresident or alien: Game and fish, $20; birds (except turkeys) and fish, $10. Not issued to applicant under 12 years of age. Resident: game and fish, $1.25. Issued by game warden or license collectors.

Hunting on own land permitted without license. American-born resident under 17 years of age may hunt without a license, if accompanied by a holder of a general license.

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[1] Game animals or birds may be killed at any time for food or clothing by native Indians or Eskimos or by miners or explorers in need of food, but game so killed can not be shipped or sold.

Bag limits and possession. One deer, 2 turkeys a season; 20 in all of ducks, geese, coot, plovers, yellowlegs, and rail, 25 quail, and 25 doves and white wings a day or in possession. Possession permitted during open season and 5 days after close of season.

Sale: The sale of all protected game is prohibited.

Export: The export of all protected game is prohibited.

ARKANSAS.

Open seasons:

Deer (with antlers not less than 5 inches long), bear	Nov. 11–Jan. 10.
Turkey gobblers (also Mar. 15–Apr. 30)	Nov. 11–Jan. 10.
Quail (partridge)	Nov. 20–Feb. 28.
Duck, goose, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rail	Sept. 1–Nov. 30.

No open season: Does, fawns, wild turkey hen, pheasant, grouse, prairie chicken, dove, woodcock (1922).

Hunting licenses:[1] For deer and turkey, nonresident $15, resident $1.10; for dog in hunting, $1.10. Issued by State treasurer and circuit clerks. Hunting prohibited on inclosed lands without consent of owner.

Bag limits and possession: Two deer, 1 bear, 4 turkeys a season, 15 squirrels a day, 20 quail and ducks in aggregate a day or in possession. Possession permitted during open season and 15 days thereafter.

Sale: The sale of deer, bear, wild turkey, quail or partridge, wild pheasant, grouse, prairie chicken, and wild fowl is prohibited.

Export: The export of all game (except rabbits) is prohibited, provided a nonresident under his license and affidavit that game is not for sale may take with him one day's bag limit.

Commission may permit game to be shipped from the State for propagation.

CALIFORNIA.[2]

Open seasons:

Male deer (except spike bucks), in districts 1, 23, 24, 25, and 26	Aug. 15–Oct. 14.
In districts 2 and 3	Aug. 1–Sept. 14.
In district 4	Sept. 1–Sept. 30.
Bear (black, brown)	Nov. 1–Mar. 1.

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[1] *Arkansas:* Fishing licenses: Resident, $1.10; nonresident, general, $5; special 15-day (trip) license, $1.25.

[2] *California:* Of the 53 fish and game districts created under the act of 1917, four (1, 2, 3, and 4) are properly hunting districts; 23, 24, 25, and 26 are fishing districts, but are open to hunting; the other 45 are fishing districts or fish and game refuges.

District 1 comprises the northern part of the State, the Sierras, and the east half of the Sacramento and San Joaquin Valleys, including all counties not included in districts 2, 3, and 4.

District 2 comprises that part of the State south of Humboldt and Tehama Counties, west of the Sacramento River and north of San Francisco Bay, including the counties of Mendocino, Glenn, Colusa, Yolo, Solano, Napa, Lake, Sonoma, and Marin.

District 3 comprises the region around San Francisco Bay and the coast counties south of the Golden Gate as far as Ventura, including the counties of Contra Costa, Alameda, Santa Clara, San Francisco, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, Ventura; also San Benito and the west half of San Joaquin, Stanislaus, Merced, Fresno, and Kern Counties.

District 4 comprises the counties in southern California, namely, Los Angeles, Orange, Riverside, San Diego, Imperial, San Bernardino, and also Inyo and Mono.

Districts 23, 24, 25, and 26 all located in District No. 1 are as follows:

District 23 comprises the drainage area of Lake Tahoe and the Truckee River in the counties of Placer and Eldorado.

District 24 comprises the drainage area of Silver, Twin, Blue, Meadow, and Wood Lakes in the counties of Alpine and Amador.

District 25 comprises the drainage area of Lake Almanor in the counties of Plumas and Lassen.

District 26 comprises Sixty Lake Basin, part of Rae Lake, and to the south fork of Woods Creek, in Fresno County.

Open seasons—Continued.

Cottontail and bush rabbit, mountain, valley, and desert quail (see exception)—Nov. 15–Jan. 31.

Exception: Mountain quail, districts 1, 23, 24, 25, and 26—Sept. 1–Nov. 30.

Tree squirrel—Sept. 1–Dec. 31.

Grouse—Sept. 15–Oct. 14.

Sage hen (except in district 4, no open season)—Aug. 15–Sept. 30.

Dove (except in district 1, Aug. 1–Oct. 31)—Sept. 1–Nov. 30.

Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule—Oct. 16–Jan. 31.

No open season: Doe, spike, buck, fawn, elk, antelope, sheep, pheasant, introduced quail or partridge, turkey, rail, plover, yellowlegs.

Hunting licenses:[1] Nonresident, $10; alien, $25; resident, $1; veterans of Civil War, free of charge. Issued by commissioners and county clerks. Unlawful to hunt in inclosure of another without permission of owner.

Bag limits and possession: Two deer, 12 tree squirrels a season; 15 cottontail or bush rabbits a day or 30 a week; 4 grouse a day or 8 a week; 4 sage hens a day or 8 a week; 10 mountain quail a day or 20 a week; 15 valley or desert quail a day or 30 a week; 15 Wilson snipe or jacksnipe a day or 30 a week; 15 mourning doves a day; 25 ducks or geese a day or 50 a week; 12 honkers or black sea brant a day or 24 a week.

Possession in excess of weekly limit prohibited. Persons killing deer must retain in possession during open season and 10 days thereafter skin and portion of head bearing horns.

Sale: Sale of deer meat and hides and quail, partridge, pheasant, grouse, sage hen, dove, rail, ibis, and shore birds is prohibited.

Hides of deer lawfully killed when duly tagged under affidavit (fee 25 cents) may be sold August 1–December 31. Cottontail and bush rabbits, coot, gallinule, duck, goose, and black brant may be sold. Domesticated reindeer may be imported and sold under regulations of fish and game commission.

Export: The export of all protected game is prohibited.

COLORADO.

Open seasons:

Rabbit, hare—Unprotected.

Prairie chicken, mountain and willow grouse—Sept. 15–Oct. 1.

Sage chicken, doves—Aug. 15–Sept. 1.

Duck, goose, brant, coot, gallinule, Wilson snipe—Sept. 16–Dec. 20.[2]

Black-bellied and golden plovers, yellowlegs—Sept. 16–Dec. 15.

Rail—Sept. 1–Nov. 30.

No open season: Deer, male (1918); elk, antelope, sheep, quail (bobwhite, crested), pheasant, black game, capercailzie (1924); doe, partridge, ptarmigan, wild turkey.

Hunting and fishing licenses: Nonresident—Big game, $25; birds, $5; fish, $2. Resident—Big game, $2; small game and fish, $1. Fishing license not required of boys under 16, or of women. Guide, $5 in addition to State hunting license. Issued by commissioner and county clerks. Unlawful to hunt in any inclosure not public land without consent of owner.

Bag limits and possession: Prairie chicken, sage hen, mountain and willow grouse, 10 in all a day, 15 in possession. Twenty other game birds a day, 35 in possession. Persons under 12 years of age limited to half this number of birds. Possession permitted during open season and first 5 days of close season. Commissioner may issue permit authorizing storage, possession, and use of game for 90 days after close of open season.

Sale: The sale of all game taken in the State is prohibited, provided, imported game may be sold under license by indorsement of shipping invoice to purchaser.

Export: The export of all protected game is prohibited; provided, birds may be exported under permit (fee 25 cents for each bird) from game commissioner if permit be attached and packages plainly marked so as to show nature of contents.

Miscellaneous: Unlawful to shoot game from public highway.

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[1] *California:* Fishing licenses required of persons 18 years of age and over: Nonresident or alien, $3; resident, $1.

[2] *Colorado:* Under an amendment of the Federal Regulations, approved by the President on October 10, 1917, the season on waterfowl, coot, and gallinules is extended to December 31.

CONNECTICUT.

Open seasons:

Deer.[1]	
Hare, rabbit (except Belgian or German hare, unprotected)	Oct. 8–Jan. 31.[2]
Gray squirrel, quail, ruffed grouse, pheasant (introduced), Hungarian partridge, woodcock	Oct. 8–Nov. 23.
Duck, goose, brant	Oct. 1–Jan. 15.
Mudhen, gallinule	Oct. 1–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Nov. 30.
Wilson or English snipe	Oct. 1–Nov. 30.
Rail	Sept. 12–Nov. 30.

No open season: Dove (1919).

Hunting licenses: Nonresident, $10.25; alien, $15.25; resident citizen, $1.25. Not issued to persons under 16. Issued by city or borough clerk. Resident and his children not required to have license to hunt on land on which he is actually domiciled, if land is not used for club or shooting purposes.

Bag limits: Six gray squirrels a day, 30 a season; 5 rabbits a day, 35 a season; 5 each of quail, ruffed grouse, pheasant, Hungarian partridge, woodcock a day, 36 a season; 35 rail, 10 shore birds, and 25 waterfowl a day.

Sale: Sale of quail, ruffed grouse, Hungarian partridge, and woodcock is prohibited.

Export: The export of quail, ruffed grouse, and woodcock is prohibited, provided, a nonresident licensee, under permit, may take out in his immediate possession game lawfully killed, when duly tagged, if not for sale.

DELAWARE.

Open seasons:

Rabbit, hare, quail, partridge, woodcock	Nov. 15–Dec. 31.
Squirrel (fox, black, gray)	Sept. 1–Oct. 15.
Dove (except in Newcastle County, no open season)	Nov. 15–Dec. 31.
Duck, goose, brant, Wilson snipe or jack snipe, coot, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plover, yellowlegs	Aug. 16–Nov. 30.
Ortolan or rail, reedbird	Sept. 1–Oct. 31.

No open season: Hungarian partridge or pheasant.

Hunting licenses: Nonresident, $10.50. Issued by commission. Unlawful to hunt on land of another without permission from owner or occupant.

Bag limits and possession: Six animals, 50 rail, 20 ducks, 12 other birds or fowl of any other species, except plover, snipe, and reedbirds, a day. Possession permitted during open season and first 5 days of close season.

Sale: Sale of all protected game is prohibited, except that a resident lawfully taking game may sell plover, snipe, and ducks anywhere, and other game in his own county; Restaurants buying from such persons may serve game in open season. Imported rabbits may be sold November 15–December 31.

Export: Export of rabbit, squirrel, quail, partridge, dove, woodcock, goose, and brant is prohibited, provided holder of license may export, open to view, 10 rabbits, 10 squirrels, 50 reedbirds, 50 rail, and 20 birds or fowl of any other species a week, lawfully killed by himself, under affidavit that the game is not for sale. Resident may export ducks, snipe, and plover. Under permit (fee, $1) of board, 10 pairs of any one species of game or birds may be captured or transported.

DISTRICT OF COLUMBIA.[3]

Open seasons:

Deer meat (sale or possession)	Sept. 1–Jan. 1.
Rabbit (except English rabbit, Belgian hare), squirrel	Nov. 1–Feb. 1.
Quail or partridge	Nov. 1–Mar. 15.
Ruffed grouse or pheasant (except English or other imported pheasants raised in inclosures, sale or possession unrestricted), wild turkey	Nov. 1–Dec. 26.

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[1] *Connecticut:* Deer may be killed with shotgun on a person's own land at any time if reported to commissioners within 24 hours.

[2] Between Nov. 24 and Jan. 1, hunting rabbits is permitted with dog and ferret only.

[3] *District of Columbia:* Hunting prohibited in the District, by act of June 30, 1906, except on the marshes of the Eastern Branch above the Anacostia Bridge and on the Virginia side of the Potomac, but in this area no birds may be shot within 200 yards of any bridge or dwelling.

Open seasons—Continued.

Prairie chicken (pinnated grouse)	Sept. 1–Mar. 15.
Marsh blackbird	Sept. 1–Dec. 15.
Duck, goose, brant, Wilson snipe, coot, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plover, yellowlegs, rail or ortolan	Sept. 1–Nov. 30.
Woodcock	Nov. 1–Dec. 31.
Reedbird	Sept. 1–Oct. 31.

No open season: Dove.

Sale: Sale permitted as follows: Waterfowl, September 16–March 31; woodcock, October 1–December 31; snipe, plover, September 1–March 31; yellowlegs, rail (ortolan), reed (rice) bird, marsh blackbird, September 1–January 31; other game during respective open seasons in table.

FLORIDA.

Open seasons:

Deer, squirrel, quail (bobwhite partridge) wild turkey, dove	Nov. 20–Mar. 1.
Ruffed grouse, imported pheasants	Nov. 20–Dec. 19.
Duck, goose, brant, black-bellied and golden plover, Wilson snipe, yellowlegs, coot, gallinules	Nov. 20–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Rail	Nov. 20–Nov. 30.

Hunting licenses: Nonresident or alien, $15 (county license, Taylor County, $25); resident, $1 (county of residence); resident, $3 (county other than county of residence). License not required in voting precinct nor of Confederate Veteran entitled to a State pension. Issued by county judge.

Bag limits and possession: Three deer, 10 turkeys, and 300 of any other game birds a year; 1 deer, 2 turkeys, 20 quail, and 25 each of other species a day. Possession permitted during open season and first 5 days of close season.

Sale: The sale of all protected game is prohibited.

Export: Export of all protected game is prohibited, except nonresident licensee may carry out game as personal baggage.

GEORGIA.

(Laws of 1917 not received.)

Open seasons:

Deer	Oct. 1–Nov. 30.
Rabbit	Unprotected.
Cat squirrel, opossum	Oct. 1–Feb. 28.
Quail, partridge, wild turkey gobblers	Nov. 20–Feb. 28.
Dove	Aug. 1–Aug. 30. Nov. 20–Feb. 28.
Duck, goose, brant, coot, gallinule, Wilson snipe	Nov. 1–Jan. 31.
Blackbellied and golden plovers, yellow legs	Nov. 20–Jan. 31.
Woodcock	Nov. 1–Dec. 31.
Reedbird	Sept. 1–Oct. 31.
Rail	Sept. 1–Nov. 30.

No open season: Fox squirrel (Jan. 1, 1918), fawn, grouse, pheasant, turkey hen, introduced game birds.

Hunting licenses: Nonresident, $15; resident, State $3, county $1 (good only in county of residence). License not required in militia district or to hunt on own or leased land. Issued by commissioner or county warden.

Bag limits: Two deer, 2 turkeys a season; 15 cat squirrels, 50 ducks, and 25 each of any other species of game birds a day.

Sale: Sale of all protected game (except migratory ducks) prohibited.

Export: Export of all protected game prohibited, provided, nonresident licensee may take out in personal possession game lawfully killed.

IDAHO.

Open seasons:

Deer, elk (see exception), goat	Sept. 16–Nov. 30.
Exception: Deer in Fremont County (no open season), in Benewah, Bonner, Boundary, Clearwater, Kootenai, Latah, Lewis, Nez Perce, and Shoshone Counties	Oct. 16–Dec. 31
Elk in Idaho County	Nov. 1–Nov. 30.
Partridge, pheasant, grouse	Aug. 16–Oct. 31.
Chinese pheasant in Ada, Canyon, Gem, Gooding, and Nez Perce Counties	Nov. 1–Nov. 10.

Open seasons—Continued.

Turtle dove	Aug. 1–Sept. 30.
Duck, goose, brant, Wilson snipe, black-bellied and golden plovers, and yellowlegs	Sept. 16–Dec. 20.[1]
Coot	Sept. 7–Dec. 20.[1]
Rail	Sept. 1–Nov. 30.

No open season: Moose, antelope, caribou, sheep, buffalo, fawn, calf elk, prairie chicken, pinnated grouse, sage hen, and imported pheasants (except Chinese pheasant as above); quail (1920).

Hunting and fishing licenses: Nonresident or alien: Big game, $25; bird, $7.50; fish, $5. Resident: Game and fish, $1. Fishing license not required of children under 12 or of women. No license required of veterans of Civil War. Persons under 12 prohibited possessing gun afield.

Bag limits: One deer, 1 elk, 1 goat a season; 8 quail, 2 Chinese pheasants, 6 in all of partridge, pheasant, grouse, turtle dove, 12 ducks, 2 geese a day or in possession; 6 black-bellied and golden plovers, 6 yellowlegs, 6 Wilson snipe, or a total of 15 in all a day or in possession.

Sale: Sale of all protected game prohibited. Hides and heads may be sold under permit.

Export: Export of all protected game is prohibited, provided, any hunter may export, under hunting license coupon, big game lawfully taken; game once shipped within State may be exported under a 50-cent permit obtained from game warden or deputy. Mounted heads and stuffed birds legally secured may be exported.

ILLINOIS.

Open seasons:

Rabbit	Sept. 1–Jan. 31.
Squirrel (gray, red, fox, black)	Aug. 1–Jan. 31.
Quail (bobwhite)	Nov. 11–Dec. 9.
Prairie chicken	Oct. 1–Oct. 15.
Introduced pheasant (cocks)	Oct. 1–Oct. 5.
Mourning dove	Aug. 15–Aug. 31.
Duck, goose, brant, Wilson snipe, coot	Sept. 16–Dec. 15.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.

No open season: Deer, wild turkey, introduced pheasant hen, sand grouse (1925); ruffed grouse (partridge), blue, mountain, and valley quail, Hungarian partridge, capercailzie, heath hen, black grouse, woodcock, rail (1920).

Hunting licenses: Nonresident or alien, $10.50. Issued by county clerk. Resident, $1. Issued by city or county clerk. Owners, their children, and tenants in actual residence may hunt on own land without license.

Bag limits and possession: Fifteen squirrels, 12 quail, 3 prairie chickens, 2 cock pheasants, 10 doves, 15 black-bellied and golden plovers, 15 snipe, 15 yellowlegs, 15 coots, rails, and gallinules, 15 ducks, 10 geese, 10 brant a day. Limit in possession, 30 squirrels, 36 quail, 12 prairie chickens, 40 doves, 50 black-bellied and golden plovers, snipe, and yellowlegs, 60 coots, rails, and gallinules, 60 ducks, 20 geese or brant.

Sale: Sale of all protected game (except rabbit during open season) is prohibited.

Export: Export of all protected game (except rabbits) is prohibited, except nonresident licensee may take from State 50 birds killed by himself, if carried openly for inspection. Holder of certificate may ship birds and game at any time for scientific or propagating purposes.

INDIANA.

Open seasons:

Rabbit	Apr. 1–Jan. 10.
Squirrel	Aug. 1–Dec. 1.
Quail, ruffed grouse	Nov. 10–Dec. 20.
Prairie chicken	Oct. 15–Nov. 1.
Duck, goose, brant	Sept. 16–Dec. 31.
Woodcock	Oct. 1–Nov. 30.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Wilson or jack snipe, coot, gallinule	Sept. 16–Dec. 20.
Rail	Sept. 1–Nov. 30.

No open season: Deer, Hungarian partridge, introduced pheasant, wild turkey, dove.

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[1] *Idaho:* Under an amendment of the Federal regulations, approved by the President on October 10, 1917, the season on waterfowl, coot, and gallinules is extended to December 31.

Hunting and fishing licenses: Nonresident, game and fish, $15.50; fish, $1. Resident, $1. Issued by clerk circuit court. Not issued to person under 14 without written consent of parent or guardian No license required of Civil War veterans, of owners of farm land, their children living with them, or tenants on own land, or of persons to fish in county of residence or contiguous counties. Wife of licensee and persons under 18 may fish without license.

Bag limits and possession: Fifteen quail, 5 prairie chickens, 15 ducks or other waterfowl a day; 45 waterfowl in possession as result of 3 or more days' consecutive hunting.

Sale: Sale of quail, prairie chickens, introduced pheasants, Hungarian partridges is prohibited.

Export: The export of deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, and other waterfowl is prohibited, except nonresident may take from State 15 birds killed by himself (or 45 if he has hunted for 3 or more days consecutively) if carried openly for inspection together with license.

Miscellaneous: Shooting on highways prohibited.

IOWA.

Open seasons:

Squirrel (gray, timber, or fox)	Sept. 1–Jan. 1.
Ruffed grouse or pheasant, wild turkey	Nov. 1–Dec. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Oct. 1–Nov. 30.
Rail	Sept. 1–Nov. 30.

No open season: Deer, elk, quail, prairie chicken, introduced pheasants, Hungarian partridge (1922); turtle dove.

Hunting and fishing licenses: Nonresident or alien, game, $10; nonresident, fish, $2 (required of males over 16 years of age). Resident citizen, $1. Issued by county auditor. Licenses not granted to person under 18 without written consent of parent or guardian. Owners of farm lands, their children, and tenants, may hunt on own lands without license. Unlawful to hunt on cultivated or inclosed lands of another without permission from owner.

Bag limits and possession: Twenty-five ducks a day, 50 in possession; 25 each of all other birds and game a day or in possession. Possession permitted during open season and first five days thereafter.

Sale: The sale of all protected game is prohibited.

Export: Export of all protected game is prohibited, except nonresident may take from State not more than 25 game birds or animals, if carried openly for inspection and if hunting license be shown on request.

KANSAS.

Open seasons:

Fox squirrel	Sept. 1–Dec. 31.
Quail, prairie chickens, pheasants (English, Mongolian, or Hungarian)	Mar. 17, 1918.[1]
Duck, goose, brant, Wilson snipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Oct. 1–Nov. 30.
Rail	Sept. 1–Nov. 30.

No open season: Deer, antelope (1921); red, gray, and black squirrels, grouse, doves.

Hunting licenses: Nonresident, $15. Issued by secretary of state. Resident, $1. Issued by county clerk. Issued free to honorably discharged soldiers or sailors of United States. No license required of resident landowner or member of family to hunt on own land. Unlawful to hunt on land of another or on highway or railroad right of way adjacent thereto without written consent of owner, unless accompanied by him.

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[1] *Kansas:* The attorney general of Kansas, in an opinion rendered the State game warden Sept. 19, 1917, states that the exception contained in ch. 201, Laws of 1917, prescribing an open season on quail and other birds from Dec. 1–15 was not included in the bill as passed by the legislature and did not become the law; and that the law of 1913, closing the season on quail and other birds, is still in force.

Bag limits: Twenty each of plover and ducks, 12 snipe, and 6 each of geese and brant a day.

Sale: Sale of all protected game birds prohibited.

Export: Export of all protected game birds prohibited.

KENTUCKY.

Open seasons:

Rabbit[1]	Nov. 15–Dec. 31.
Squirrel (black or fox)	July 1–Dec. 15.
Quail	Nov. 15–Jan. 1.
Dove	Sept. 1–Oct. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rail	Sept. 1–Nov. 30.

No open season: Deer, elk (1921); native and introduced pheasants, Hungarian partridge, wild turkey (1920); woodcock.

Hunting licenses: Nonresident or alien, $7.50. Resident, $1. Issued by county clerk. Resident land owner, tenant, and members of families may hunt on own land without license. Unlawful to enter inclosed lands of another for shooting, hunting, or fishing without consent.

Bag limits and possession: Twelve quail a day, 12 in possession for each day of hunt; 15 doves a day, 15 in possession for each day of hunt.

Sale: The sale of quail, partridge, grouse, introduced or native pheasant, Hungarian partridge, wild turkey, wherever killed, is prohibited.

Export: The export of deer, elk, and all game birds is prohibited, except lawfully killed game may be transported in possession of hunter.

LOUISIANA.

Open seasons:

Deer (see exception)	Sept. 15–Jan. 5.[2]
Exception: South of Vernon, Rapides, Avoyelles, and Concordia Parishes, and Mississippi State line	Oct. 1–Jan. 20.
Bear	Nov. 1–Feb. 1.
Raccoon, opossum	Nov. 1–Feb. 15.
Squirrel	Oct. 1–Feb. 15.
Dove, Florida duck (black duck)	Nov. 1–Feb. 15.
Quail, wild turkey gobblers	Nov. 15–Mar. 1.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe, yellowlegs, rail, coot, gallinule	Nov. 1–Jan. 31.
Woodcock	Nov. 1–Dec. 31.

No open season: Fawns, elk (1919); prairie chicken, introduced pheasant, wild turkey hen, upland plover (papabotte) (1920).

Hunting licenses: Nonresident or alien, $15; resident, $1; market hunting, $10. Issued by tax collectors. Nonresident or alien not permitted to hunt for profit. No license required of person to hunt on land owned or leased for agricultural purposes. Alien may hunt on own land without license. License does not authorize hunting on land of another without his written consent.

Bag limits and possession: Two deer a day or in possession, 5 a season; 15 squirrels, 1 turkey gobbler, 25 doves, ducks, poule d'eau, or chorooks, 50 snipe, 15 of any other game birds a day.

Sale: Sale of all protected game prohibited (except snipe, rail, coots, poule d'eau, duck, goose, and brant, which may be sold from Dec. 15 to Feb. 15).

Export: Export of all protected game prohibited, except a nonresident licensee may carry with him out of the State, under his license, one day's bag limit of game, if not for sale. Game for propagation, head, hide, feet of quadrupeds, and the plumage or skins of birds legally taken when properly marked. Bears may be exported under permit.

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[1] *Kentucky:* Rabbits may be taken with dogs or snares at any time for own use on own land, but not for sale or barter.

[2] *Louisiana:* Deer season fixed by conservation commissioner.

MAINE.[1]

Open seasons: [2]

Deer (see exception)—Oct. 1–Dec. 15.
Exception: In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties, Nov. 1–Nov. 30.
Hare, rabbit—Oct. 1–Mar. 31.
Gray squirrel—Oct. 1–Oct. 31.
Ruffed grouse, partridge, woodcock—Oct. 1–Nov. 30.
Duck, goose, brant, Wilson snipe, coot, gallinule—Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs—Aug. 16–Nov. 30.
Rail—Sept. 1–Nov. 30.

No open season: Deer on Cross, Scotch, and Mount Desert Islands and in towns of Deer Isle and Stonington, in Hancock County. Bull moose (1919); cow and calf moose, caribou, quail, Hungarian partridge, pheasant, black game, capercailzie, cock of the woods, dove.

Hunting and fishing licenses: Nonresident, October 1–December 31, $15; prior to October 1 in Aroostook, Franklin, Hancock, Oxford, Penobscot, Piscataquis, Somerset, and Washington Counties, $5; season (except November) in balance of State, $5. For November, $15 license required, which may be obtained by holder of $5 license on payment of $10 additional. Nonresident must be accompanied by registered guide while hunting or fishing on wild lands prior to November 30. Nonresident fishing license, $2.15 (not required of children under 14 years of age). Resident alien, game, $15 (not required of aliens who pay taxes or who have resided in State two years continuously prior to application). Guide licenses: Nonresident, $20; resident, $1. Must not guide more than five persons hunting at one time. Shipping licenses (within State): Resident, deer, $2; one pair of game birds in seven days, 50 cents.

Bag limits and possession: Two deer a season (except in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties, limit 1, and in lumber camps, limit 2); 5 each of ruffed grouse and plover, and 10 each of woodcock, snipe, and ducks a day. Reasonable time allowed after close of season to transport game to home of owner, and deer may be possessed during closed season.

Sale: Sale of all protected game birds and deer for export prohibited. Deer may be sold by local dealers under license.

Export: Export of all protected game is prohibited, provided a resident of the State may export 1 deer a season if open to view, tagged to show name and address of owner, and accompanied by him, and under shipping license 5 partridges, 10 woodcock, and 10 ducks (fee $5), lawfully killed by himself. A nonresident may export under hunting license tags 2 deer lawfully killed by himself, and may take home 5 partridges, 10 ducks, and 10 woodcock; he may also ship out one pair of game birds a month under a special 50-cent license. Live game may be exported for breeding, scientific, or advertising purposes under permit of the commissioner of inland fisheries and game.

MARYLAND.

Open seasons:

Rabbit—Nov. 10–Dec. 24.
Squirrel (see exceptions)—Aug. 25–Oct. 1. Nov. 10–Dec. 24.
Exceptions: In Allegany County—Sept. 15–Dec. 24.
In Cecil—Aug. 25–Oct. 25.
In Frederick—Aug. 25–Dec. 24.
In Anne Arundel, Calvert, Charles, Dorchester, Prince Georges, and Talbot—Nov. 10–Dec. 24.
In St. Mary—Unprotected.
Quail, ruffed grouse, wild turkey, introduced pheasant, woodcock, (see exceptions)—Nov. 10–Dec. 24.
Exceptions: Quail in Frederick (1921); ruffed grouse, ringnecked pheasant, wild turkey in Harford (no open season); ruffed grouse, introduced pheasants in Wicomico (1921).
Dove in Talbot County only—Aug. 15–Dec. 24.

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[1] *Maine:* Commissioners may make local regulations; and governor may suspend hunting seasons during drought.

[2] All hunting is prohibited on Kineo Point, Piscataquis County; on Back Bay above Grand Trunk Railroad bridge, and on Richmonds Island, Cumberland County; southern point Swan Island; and locally in town of Eden, Hancock County.

Open seasons—Continued.

Duck, goose, brant, Wilson snipe, coot, gallinule—Nov. 1–Jan. 31.[1]
Black-bellied and golden plovers, yellowlegs—Aug. 16–Nov. 30.[1]
Reedbird, sora (water rail or ortolan)—Sept. 1–Oct. 31.

No open seasons: Deer, elk (1922); dove (except as above in Talbot County).

Hunting licenses: Nonresident license fees range from $4.50 to $20.50, and licenses are issued by clerks of circuit court, except in Cecil and Harford Counties, where they are issued by Cecil County Game Protective Association and by justices of the peace, respectively.

County and local licenses are issued to nonresidents at the following rates (including clerk fees): "(of State)" means nonresident of Maryland; "(of county)" means nonresident of particular county or of Maryland:

Allegany (of State)	[2] $5.00	Howard (of State)	[2] $20.50
Anne Arundel (of county)	5.20	Kent (of county	[3] 15.50
Baltimore (of State)	[2] 10.20	Montgomery (of county)	15.50
Calvert (of State)	10.50	Patuxent River (of State)	[4] 11.00
Caroline (of county)	5.25	Prince Georges (of county)	20.50
Carroll (of State)	10.50	Queen Anne (of county)	4.50
Cecil (of county)	10.00	St. Mary (of State)	20.50
Charles (of State)	5.50	Somerset (of State)	[2] 10.50
Dorchester (of State)	[2] 10.00	Talbot (of county)	10.00
Frederick (of county)	[5] 15.50	Washington (of county)	10.00
Garrett (of county)	10.50	Wicomico (of State)	10.50
Harford (of county)	5.15	Worcester (of State)	10.00

County licenses are required of residents at the following rates (including clerk fees):

Allegany (also issued to residents of Garrett and Washington Counties)	$1.00	Baltimcre	$1.20
Anne Arundel (resident or tax-payer)	1.20	Dorchester (resident or tax-payer)	1.00
		Harford	1.15
		Somerset	2.75
		Washington	.50

Guests: Guests of landowners require no license except in Allegany, Baltimore, Caroline, Cecil, Charles, Dorchester (except relatives of host), Frederick, Garrett, Harford, Kent, Talbot, Washington, and Worcester Counties.

Sinkbox, sneak boat, blind, pusher.—Cecil: Sneak boat (Bohemia and Elk Rivers), $5.50; sinkbox (Bohemia, Elk, and Sassafras Rivers), $10.50. *Anne Arundel:* Pusher, $2; booby and brush blinds (west side Chesapeake Bay), $5; (South River), $2.50. *Harford:* Sinkbox, $20.75; sneak boat, $5.75. *Kent:* Sinkbox, $20; blind, $5. *Queen Anne:* Sinkbox, $10.50; sneak boat, $5.75; booby blind, $2.50. *Susquehanna Flats:* Sinkbox, $20.75; sneak boat, $5.75. *Talbot:* Sinkbox, $5; blind or sinkbox (Dickson Bay), $5. *Patuxent River:* Pusher, $2.50 (required of residents to push or paddle nonresidents).

Anne Arundel prohibits hunting by nonresidents of the county except by permission of landowners, and Charles prohibits hunting of waterfowl by nonresidents.

Bag limits: Four wild turkeys a season; 10 rabbits, 10 squirrels, 12 quail (partridge), 2 ruffed grouse, 3 English pheasants, 6 woodcock, 10 jacksnipe, 15 yellowlegs, 5 black-bellied plover, 50 reedbirds, 50 rail, 10 coots (crow bills) and gallinules a day; 25 waterfowl a day for each licensed gunner (not exceeding 4) connected with an outfit.

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[1] *Maryland:* Wild fowl shooting permitted: On the Susquehanna Flats north of a line extending from Turkey Point Lighthouse, Cecil County, and half a mile north of Spesutia Island to Oakington, Harford County, on Mondays, Wednesdays, and Fridays, Nov. 1–Jan. 1, and Mondays, Wednesdays, Fridays, and Saturdays, Jan. 1–Jan. 31; in Harford County only before 2 p. m.; in Anne Arundel County, on Magothy River on Tuesdays, Thursdays, and Saturdays; on Rhode and West Rivers on Mondays, Wednesdays, and Fridays; on Severn River on Mondays, Wednesdays, and Saturdays; in Cecil County, on Bohemia, Elk, and Sassafras Rivers on Mondays, Wednesdays, Fridays, and Saturdays; in Dorchester County, on Choptank River on Tuesdays, Thursdays, and Saturdays; in Kent County, on Chester River above Cliff City and Spaniard Point on Mondays, Fridays, and Saturdays.

[2] Resident of State, Allegany (except residents of Garrett and Washington Counties), fee $3; Baltimore, fee $5.20; Dorchester, fee $5; Howard, fee $5.50; Somerset, fee $2.75.

[3] Fee only $5.50 if inivited by resident landowner.

[4] Club license, $25.

[5] Not requird if written permission be secured from landowner or lessee.

Bag limits—Continued.

Additional county restrictions: Allegany, 2 wild turkeys a day. Baltimore, 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 1 English pheasant, 1 ring-necked pheasant, 1 wild turkey a day. Calvert, 6 rabbits a day. Cecil, 5 rabbits, 6 squirrels, 50 blackbirds a day. Frederick, 8 rabbits, 5 woodcock a day. Garrett, 6 birds a day (see State limits for exceptions). Harford, 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock a day or in possession. Talbot, 12 doves.

Sale: The sale of game is prohibited under county laws, as follows:

Allegany—Deer, squirrel, hare, quail, grouse, introduced pheasant, wild turkey, dove, woodcock.

Anne Arundel—All game (except squirrel, rabbit, and raccoon).

Baltimore—Rabbit, squirrel, quail, ruffed grouse, dove, pheasant, woodcock, for export.

Calvert—Rabbit, quail, woodcock, for export for sale.

Carroll—Squirrel, partridge, pheasant, dove, woodcock.

Cecil—All protected game (except rabbit, rail, reedbird, and duck).

Dorchester—Rabbit, squirrel, quail, partridge, dove, woodcock, for export.

Frederick—Rabbit, squirrel, partridge, pheasant, woodcock, snipe, taken in county.

Garrett—Partridge, quail, pheasant, wild turkey, woodcock, for export.

Harford—Rabbit, squirrel, quail (for sale).

Montgomery—Rabbit, quail, partridge, woodcock, for export.

Somerset—Rabbit, quail or partridge, woodcock, dead or alive, for any other purpose than as food within the county or for propagation; or any game for export.

Washington—All game.

Wicomico—Quail or partridge for export (Wicomico and Worcester Counties considered as one territory).

Worcester—Rabbit, quail, woodcock (except to consumer).

Export: The export is prohibited of all protected game (except waterfowl), provided:

A licensed hunter may take out under his license an amount equal to one day's bag limit of game, if not for sale.

County provisions are as follows:

Allegany—All protected game (for sale).

Anne Arundel—All protected game, viz: Squirrel, rabbit, quail, partridge, pheasant woodcock, snipe, plover, duck, goose, brant from county.

Baltimore—Rabbit, squirrel, quail, partridge, pheasant, dove, woodcock from county.

Calvert—Rabbit, partridge, woodcock from county (for sale, barter, or trade).

Carroll—Squirrel, quail, pheasant, dove, woodcock.

Exception: Twelve squirrels, 10 quail, 3 pheasants, 12 doves, 6 woodcock, by guest of landowner or nonresident licensee as personal baggage and not for sale.

Caroline—Rabbit, quail, partridge, woodcock from county.

Cecil—Squirrel, quail, grouse, woodcock, plover from county.

Dorchester—All protected game.

Exception: Twelve quail or partridges, 6 each of squirrels, rabbits, woodcock, and doves may be taken out of the county at one time as personal baggage, if carried openly and not intended for sale.

Frederick—Rabbit (for sale), squirrel, partridge, pheasant, woodcock from county (for sale).

Garrett—Partridge, pheasant, wild turkey, woodcock from State.

Exception: Rabbit, if shipped openly, Nov. 10–Dec. 25. Nonresident may take out game killed under his hunting license.

Harford—Rabbit, squirrel, quail.

Exception: Nonresident licensee may take out 6 rabbits, 1 jack rabbit, 8 squirrels, 10 quail, 5 woodcock, 10 jacksnipe, 50 rail for private use.

Kent—Squirrel, rabbit, and all birds from county (for sale, except under license).

Montgomery—Rabbit, partridge, quail, woodcock from county (for sale).

Exception: Nonresident licensee may take out game lawfully killed.

Queen Anne—Rabbit, partridge, woodcock from any county (for sale).

Somerset—All game, viz: Squirrel, rabbit, quail or partridge, pheasant, dove, woodcock, duck, goose from county.

Talbot—All game.

Exception: Six rabbits, 6 squirrels, 12 quail, 6 doves, 6 woodcock may be taken out if not for sale.

Washington—Deer, squirrel, rabbit, partridge, pheasant, dove, woodcock, turkey from county (for sale).

Wicomico—Quail or partridge from Wicomico and Worcester Counties considered as one territory.

Worcester—Rabbit, quail, woodcock from county.

MASSACHUSETTS.

Open seasons: [1]

Deer (first Monday in December to the following Saturday, inclusive)—Dec. 3–Dec. 8.
Hare or rabbit (see exceptions)—Nov. 1–Feb. 28.
Exceptions: Hare or white rabbits in Bristol and Norfolk Counties, 1920; European hares in Berkshire County, unprotected.
Gray squirrel, quail, ruffed grouse or partridge, woodcock (see exceptions)—Nov. 1–Nov. 30.
Exceptions: Quail in Hampden and Middlesex Counties (1922); in Essex County (1919).
Woodcock in Berkshire, Franklin, Hampden, and Hampshire—Oct. 20–Nov. 30.
Introduced pheasants (see exception)—Nov. 1–Nov. 30.
Exception: In Barnstable, Dukes, and Nantucket Counties—No open season.
Duck, goose, brant, Wilson snipe, gallinule, quark (mudhen)—Sept. 16–Dec. 31.
Rail—Sept. 1–Nov. 30.
Black-bellied and golden plovers, yellowlegs—Aug. 16–Nov. 30.

No open season: Moose, dove, prairie chicken, Hungarian partridge, pheasants (English, golden, Mongolian),[2] heath hen.

Hunting licenses: Nonresident citizen, $10. Members of incorporated game clubs owning real estate assessed at not less than $1,000 and organized prior to 1907, owners, or their minor children over 18 years old, of real estate assessed at not less than $500, or nonresidents invited (for not more than four days) by members of incorporated club for hunting foxes pay a fee of $1. Resident citizen, $1. Minors under 16 years of age must furnish written consent of parent or guardian. License not required of resident for hunting on own land used exclusively for agricultural purposes and on which he is actually domiciled. Alien, $15 (applicant must own real estate to the assessed value of $500). Issued by city or town clerks.

Bag limits: One deer, 15 gray squirrels, 15 ruffed grouse, 20 woodcock, 20 quail a season; 5 gray squirrels, 3 ruffed grouse, 4 woodcock, 4 quail, 15 black ducks a day; pheasants, in counties having open season, 2 a day, 6 a season.

Sale: The sale of all game (except hare and rabbit) is prohibited, provided, deer, moose, caribou, and elk lawfully killed and imported into the State under warden's tag may be sold under license at any time. Dealers may sell under license unplucked bodies of pheasants, Scotch grouse, European black game, red-legged partridge, Egyptian or migratory quail, European black plover, and mallard ducks imported from without the United States. The above game must be tagged; fee, 5 cents a tag. Hares or rabbits lawfully secured may be sold at any time. Live quail and waterfowl for propagation may be sold under permit.

Export: The export of quail, ruffed grouse, and woodcock taken in State, and other game illegally taken in State is prohibited, provided, nonresident may take 10 wild fowl or birds of all kinds out of the State and into any other State according similar privileges under his hunting license if open to view and the commission or the district deputy has been notified.

Miscellaneous: Deer may be taken with a shotgun only. Unlawful to hunt or kill game with rifle or revolver during open season for deer.

MICHIGAN.

Open seasons: [3]

Deer (see exceptions)—Nov. 10–Nov. 30.
Exceptions: Deer in red coat, fawn in spotted coat; all deer on Bois Blanc Island (1918); in Berrien, Calhoun, Genesee, Ingham, Jackson, Kalamazoo, Oakland, and St. Clair Counties (1920).
Rabbit—Oct. 1–Feb. 1.
Ruffed grouse (partridge), woodcock—Oct. 1–Nov. 9.
Duck, goose, brant, Wilson snipe, coot, gallinule—Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellow legs—Sept. 1–Dec. 15.

No open season: Elk, moose, caribou, European partridge, dove, rail, squirrel, quail, introduced pheasants, black game, capercailzie, hazel grouse, Canada or spruce grouse, prairie chicken, wild turkey (1920).

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[1] *Massachusetts:* Governor may suspend open seasons during extreme drought.
[2] Commission may open season on pheasants.
[3] *Michigan:* Seasons may be shortened or closed by order of commissioner.

Hunting licenses:[1] Nonresident or alien: Deer, $25; small game, $10. Resident: Deer, $1.50; small game, $1. Issued by county clerks, commissioner, or deputy. Export, issued by commissioner, $10. Licenses issued to persons under 17 and over 12 on application of parent or guardian, who must accompany such minor when hunting. No license required of residents or minor children hunting on own inclosed land on which they reside.

Bag limits and possession: One deer a season; partridge, 6 a day, 15 in possession, 25 a season; ducks, 25 a day, 50 a calendar week; geese and brant, 6 a day, 15 in possession, 25 a season; woodcock, 6 a day, 20 in possession, 25 a season; Wilson snipe, black-bellied and golden plovers, and yellowlegs, 10 a day, 20 in possession, 25 a season. Possession permitted during open season and 30 days thereafter. Camping party of six or more licensed hunters may, under permit (fee 50 cents each), kill one deer for camp purposes.

Sale: Sale prohibited of all protected game, except rabbit, provided deer skins and green or mounted buck-deer heads lawfully taken may be sold under permit. Dealers may sell under license unplucked carcass of pheasants of all species, Scotch grouse, European black game, European black plover, red-legged partridge, Egyptian quail, European red deer, fallow deer, roe buck, and reindeer lawfully imported from another State or country, if properly tagged on arrival in State. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of said imported and tagged game to patron or customer for actual consumption or use.

Export: Export prohibited of all protected game.

Exceptions: (1) Deer may be transported outside the State to reach a point within the State.

(2) Nonresident licensee may take out, as hand baggage, open to view, 1 day's bag limit of birds, and may ship one deer when license tag and seal are attached, if permit on back of license coupon is canceled by agent at initial point of billing.

(3) Landowners and members of clubs owning game preserves may take out as hand baggage during open season under a $10 permit from State warden 20 ducks or other migratory birds killed by them on their own premises.

(4) Deer skins and green or mounted buck-deer heads may be exported under permit.

MINNESOTA.

Open seasons:

Deer, bull moose	Nov. 10–Nov. 30.
Bear, squirrel	Oct. 15–Feb. 28.
Quail, partridge	Nov. 1–Nov. 30.
Sharp-tailed or white-breasted grouse, prairie chicken (pinnated grouse), Wilson snipe or jacksnipe, coot, gallinule, rail, yellowlegs	Sept. 16–Sept. 30.
Duck, goose, brant	Sept. 16–Nov. 30.

No open season: Elk, cow moose, caribou, fawn; imported pheasants, woodcock, golden plover, dove, ruffed grouse (1920).

Hunting licenses: Nonresident or alien: Animals, $25; birds, $10. Issued by commissioner. Resident: Animals, $1; birds, $1. Issued by county auditor. No license required of residents under 14, or of owners, lessees, or members of their immediate families to hunt on own or leased land occupied by them as permanent residence. Unlawful to enter growing grain fields for purpose of hunting.

Bag limits and possession: One deer or 1 antlered moose, 25 prairie chickens a season; 15 ducks a day, 45 in possession; 10 quail a day, 20 in possession, 30 a season; 5 other birds a day, 30 in possession. Possession permitted during open season and 5 days thereafter. Under permit, deer and moose may be possessed to January 31 and game birds to December 31.

Sale: Sale prohibited of all protected game.

Export: Export prohibited of all protected game, except nonresident licensee may ship home in open season under his license coupons 1 deer, or 1 bull moose, and 25 birds lawfully taken by himself. Deer and moose hides for tanning and heads for mounting may be exported when tagged with license coupon.

MISSISSIPPI.

Open seasons:[2]

Deer (male), bear	Nov. 15–Mar. 1.
Rabbit, squirrel	Unprotected.
Quail or partridge	Nov. 1–Mar. 1.

[1] *Michigan:* Fishing licenses: Nonresident (males over 21), general, $5; special, $1 (fish, except grayling, salmon, and trout).

[2] *Mississippi:* Local regulations of boards of supervisors also in force.

Open seasons—Continued.

Wild turkey gobblers	Jan. 1–May 1.
Dove	Aug. 1–Mar. 1.
Waterfowl, Wilson snipe or jacksnipe, coot, poule d'eau, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Nov. 1–Dec. 31.
Rail (mud hen)	Sept. 1–Nov. 30.

No open season: Does; turkey hens (1921).

Hunting licenses: Nonresident, $20 (county license). Issued by sheriff. Landowners and their nonresident relatives and friends may hunt on own lands without license.

Bag limits: One deer a day, 5 a season; 20 game birds a day.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited.

MISSOURI.

Open seasons:

Deer (buck), wild turkey	Nov. 1–Dec. 31.
Squirrel (gray, black, fox)	June 1–Dec. 31.
Quail (bobwhite partridge)	Nov. 10–Dec. 31.
Dove	Aug. 1–Nov. 10.
Duck, goose, brant, Wilson snipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 15–Dec. 15.
Rail	Sept. 15–Nov. 30.

No open season: Does, fawns under 1 year of age, ruffed grouse (pheasant), prairie chicken (pinnated grouse), woodcock, imported pheasants, other introduced game birds.

Hunting licenses: Nonresident, $25. Issued by commissioner. Resident, State, $5; county, $1, good in county of residence or adjoining county. Issued by county clerk or license collector. Owners and tenants of agricultural lands and members of family under 21 may hunt on own or leased land without license. Hunting on land of another prohibited without his consent.

Bag limits and possession: One deer, 2 turkeys, 10 quail, 15 of any other species of birds a day; or 2 deer, 4 turkeys, 15 quail, 25 of any other species of birds in possession. Possession permitted during open season and first 5 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him. Export (except of quail) for scientific or propagating purposes allowed under permit.

MONTANA.

Open seasons:

Deer (see exception)	Oct. 1–Nov. 30.
Exception: Deer in Custer, Dawson, Richland, Rosebud, and Yellowstone Counties	Oct. 1, 1922.
Elk in Flathead, Lincoln, Phillips, Teton, and parts of Missoula and Fowell Counties	Oct. 1–Nov. 30.
In Carbon, Gallatin, Madison, Park, Stillwater, and Sweetgrass Counties	Oct. 1–Dec. 14.
Pheasant, partridge, prairie chicken, sage hen, fool hen, grouse	Sept. 15–Sept. 30.
Duck, goose, brant	Sept. 15–Nov. 30.
Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs, coot	Sept. 7–Dec. 20.
Rail	Sept. 1–Nov. 30.

No open season: Sheep, goat (1922), elk (except as above), moose, caribou, antelope, bison or buffalo, quail, introduced pheasant, dove.

Hunting and fishing licenses: Nonresident: General, $50; birds and fish, $15; fish, $3. Alien: General, $50; fish, $5. Resident: General, $1.50. Guide (resident), $10. Shipping (export), 50 cents. Issued by warden or deputy. Elk (special), $25 (2 elk in Park and Gallatin Counties). Issued by warden.

No license required of female under 18 or of male under 14. Alien not holding a hunting license required to obtain from warden $25 license to possess firearms.

Bag limits and possession: One deer, 1 elk a season; 5 each of grouse, partridges, prairie chickens, fool hens, pheasants, sage hens, and 20 ducks a day or in possession. Under $25 permit 2 elk in counties of Park and Gallatin.

Sale: Sale of all protected game prohibited, except merchant or hotel or restaurant keeper may sell game killed outside the State.

Export: Export of all protected game prohibited, except game lawfully killed may be exported in open season as baggage or express if accompanied by owner and shipping permit from State warden, or under nonresident's hunting license; total shipments under one license not to exceed season's bag limit; packages to be labeled to show contents.

NEBRASKA.

Open seasons:

Squirrel (gray, red, fox, timber)	Oct. 1–Nov. 30.
Prairie chicken, sage chicken, grouse	Sept. 15–Nov. 15.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinules	Sept. 16–Dec. 31.
Yellowlegs	Sept. 16–Dec. 15.
Rail	Sept. 1–Nov. 30.

No open season: Deer, elk, antelope, quail, partridge, pheasant, ptarmigan, introduced game birds, dove, wild turkey, plovers, woodcock.

Hunting and fishing licenses: Nonresident: General, $10; fish, $2. Resident, $1. Issued by commissioner or county clerk. No license required by owner or lessee to hunt or fish on lands on which he resides. No license required by male under 18 if accompanied by parent or guardian; male under 18 and female may fish without license. Hunting on land of another without permission or from highways prohibited.

Bag limits and possession: Ten each of squirrels, quail, prairie chickens, grouse, wild geese or brant, and 25 game birds of any other variety a day; 20 squirrels, 10 prairie chickens or grouse, 10 wild geese or brant, or 50 other game birds in possession. Possession permitted during open season and first 5 days of close season.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited, except nonresident may ship 50 birds out of State under hunting license, but must give common carrier invoice of number and kind of birds, must have details of shipment marked on license, and must accompany the shipment; package to be labeled to show contents.

NEVADA.

Open seasons: [1]

Deer	Oct. 15–Nov. 15.
Prairie chicken	Oct. 1–Jan. 15.
Sage hen	July 15–Sept. 1.
Duck, goose, brant, Wilson or jacksnipe, coot, gallinule	Oct. 1–Jan. 15.[2]
Black-bellied and golden plovers, yellowlegs	Oct. 1–Dec. 15.
Rail	Sept. 1–Nov. 30.

No open season: Elk, antelope, sheep, goat (1930); pheasants (1920); mountain quail, grouse (1922).

Hunting and fishing licenses: Nonresident: Game, $5; fish, $5. Alien: Fish, $15. Resident citizen: Game, $1, fish, $1. Issued by county clerks and wardens. Aliens prohibited from hunting. No license required of boys under 14, or of women, or of person hunting or fishing on own land.

Bag limits and possession: One deer a season; 10 sage hens, 20 ducks, 5 geese, 5 brant, 15 snipe a day or in possession.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited.

NEW HAMPSHIRE.

Open seasons: [3]

Deer in Coos County	Oct. 15–Dec. 15.
In Carroll (except town of Moultonborough) and Grafton Counties	Nov. 1–Dec. 15.
In town of Moultonborough and counties of Belknap, Merrimack, and Strafford	Nov. 15–Dec. 15.
In Cheshire, Rockingham, and Sullivan Counties	Dec. 1–Dec. 15.
In Hillsboro County	Dec. 15–Dec. 31.

[1] *Nevada:* County commissioners may shorten open seasons on game and with approval of State warden may fix seasons on valley quail and doves.

[2] Under an amendment of the Federal Regulations, approved by the President on October 10, 1917, the season on waterfowl, coot, and gallinules is closed on December 31.

[3] *New Hampshire:* Governor and council may suspend open season in time of excessive drought.

Open seasons—Continued.

Hare, rabbit	Oct. 1–Feb. 28.
Quail, partridge, ruffed grouse, woodcock	Oct. 1–Nov. 30.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Rail	Sept. 1–Nov. 30.

No open season: Elk, moose, caribou, dove, pheasant, European partridge; gray squirrel (1919).

Hunting and fishing licenses: Nonresident: Game and fish, $15; fish, $1. Resident: game and fish, $1. Issued by commissioner or town clerk. Licenses not granted to children under 13 years of age, and only with written consent of parent or guardian to minors under 16 years. Child under 13 may hunt without license when accompanied by licensed parent or guardian. Resident owner of farm lands and minor children may hunt on own land without license. Guide: Nonresident, $20; resident, $1. Issued by commissioner.

Bag limits and possession: Two deer a season in Coos, Carroll, and Grafton Counties or 1 in rest of State; 5 hares, 5 quail a day; 10 ruffed grouse a day, 50 a season; 10 woodcock a day, 50 a season; 20 ducks a day. Deer may be possessed for a reasonable time after close of open season.

Sale: Sale for food purposes of the dead bodies of birds belonging to a family any species or subspecies of which is native to and protected by the State is prohibited, provided, deer, hares, and rabbits may be sold during the open season.

Export: Export of all protected game prohibited provided game (except ruffed grouse) imported from without the United States or raised in private preserves when tagged and marked to show kind and number, name and address of consignor and consignee, and initial point of billing and destination, may be exported unaccompanied by the owner. Game for propagation, the head, hide, feet, or fur of game quadrupeds, and the plumage or skin of game birds legally taken and possessed may be transported without being marked. Nonresident may take with him out of the State, under his hunting license and permit, one day's limit of game birds when properly marked and tagged, and 2 deer under license tags.

NEW JERSEY.

Open seasons:

Deer[1] (male, with horns visible above the hair)	Oct. 17, 24, 31, and Nov. 7.
Rabbit, squirrel, quail, ruffed grouse (partridge), prairie chicken, Hungarian partridge, English or ring-neck pheasant cocks	Nov. 10–Dec. 15.
Duck, goose, brant, coot, gallinule	Oct. 1–Jan. 15.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Wilson snipe or jacksnipe	Oct. 1–Dec. 31.
Woodcock	Oct. 10–Nov. 30.
Reedbird	Sept. 1–Oct. 31.
Marsh hen, rail	Sept. 1–Nov. 30.

No open season: Does and fawns; English or ringneck pheasant hens, wild turkey (1919); dove.

Hunting and fishing licenses: Nonresident: Game and fish, $10.15; fish, $2.15. Resident male citizen above age of 14: Game and fish, $1.15. When applied for by parent or legal guardian, in discretion of commissioner, license may be granted to citizen between the ages 10 and 14 to hunt when accompanied by adult holder of a general license; fee, $1. Issued by county, city, or town clerk or salaried warden.

Unnaturalized foreign-born person prohibited from hunting or owning shotgun or rifle unless he is the owner of real property to the value of $2,000 above all improvements.

Bag limits and possession: One deer a season, 10 rabbits, 10 quail, 3 ruffed grouse, 3 English or ringneck pheasants, 3 Hungarian partridges, 10 woodcock, 30 marsh hens, 20 ducks, 10 each of geese and brant a day or in possession.

Sale: The sale of deer, squirrel, and game birds (except waterfowl, reedbird, and rail) belonging to a family any species of which is native to and protected by the State is prohibited, provided rabbit, rail, reedbird, and waterfowl during open season and 15 days thereafter; certain imported game, also deer, pheasants, and black and mallard ducks coming from another State, may be sold at all times of the year if properly tagged.

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[1] *New Jersey:* Wild deer may be taken only with shotgun not smaller than 12 gauge.

Export: Export of hare, rabbit, squirrel, woodcock, waterfowl, and all other protected upland game birds is prohibited, except nonresident licensee may carry openly from the State 10 rabbits, 50 reedbirds, 50 rail, and 15 other game birds a day.

Miscellaneous: Unlawful to use shotgun or rifle holding more than two cartridges or that may be fired more than twice without reloading.

NEW MEXICO.

Open seasons:

Deer (with horn):	
North of latitude 35°	Oct. 16–Nov. 5.
South of latitude 35°	Oct. 25–Nov. 25.
Squirrel (tassel-eared gray)	June 1–Nov. 30.
Quail (except bobwhite)	Oct. 25–Dec. 31.
Grouse	Sept. 16–Nov. 25.
Wild turkey:	
North of latitude 35°	Nov. 1–Dec. 31.
South of latitude 35°	Oct. 25–Nov. 25.
Turtle dove	Aug. 16–Sept. 30.
Duck, goose, brant, Wilson snipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Rail	Sept. 1–Nov. 30.

No open season: Does, Sonoran deer, elk, sheep, goat, antelope, buffalo, bobwhite quail, pheasant, ptarmigan, prairie chicken, sage hen (1920).

Hunting and fishing licenses: Nonresident: Game and fish, $30; game, $25; birds, $10; fish, $5. Nonresident alien: Game and fish, $55; game, $50. Resident alien: Game and fish, $30; game, $25. Resident: Game and fish, $2; game, $1.50; big game, $1; birds, $1; fish, $1; guide, $5. Duplicate license, $1. Issued by county clerk or deputy.

Bag limits and possession: One deer a season, 3 wild turkeys, 5 grouse, 20 quail, 20 doves, 20 ducks a day or in possession. Possession permitted during open season and first 5 days of close season. Under permit, game may be held in storage for first 30 days of close season.

Sale: Sale of all protected game taken in the State is prohibited.

Permitted: Sale of game imported into State by hotel, restaurant, café, boarding-house keeper, or dealer under a permit good for not more than 30 days.

Export: Export of all game taken in the State prohibited, except transportation of game is permitted under license coupon or 25-cent permit ($2 in case of export of deer); holder of hunting license, under permit from warden, may export game or birds for scientific or propagating purposes.

NEW YORK.

Open seasons: [1]

Deer (with horns not less than 3 inches long) in Adirondack region [2] (see exceptions)	Oct. 1–Nov. 15.
Exceptions: In Ulster County and towns of Neversink, Cochecton, Tusten, Highland, Lumberland, Forestburg, Bethel, and all of towns of Mamakating and Thompson south of Newburgh and Cochecton turnpike in Sullivan County, and Deer Park, in Orange County	Nov. 1–Nov. 15.
On own land in Columbia, Dutchess, and Rensselaer Counties with shotguns only	Oct. 1–Nov. 15.
Varying hare, rabbit [3]	Oct. 1–Jan. 31.
Squirrel, black, gray, or fox (no open season in corporate limits of city or village)	Oct. 1–Nov. 15.
Grouse, partridge [3]	Oct. 1–Nov. 30.

[1] *New York:* When date of open or close season falls on Sunday, season opens or closes on the preceding Saturday, except on migratory birds.

[2] The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Jefferson, Lewis, Oneida, Oswego, Saratoga, St. Lawrence, Warren, and Washington.

[3] Open season on upland game fixed or closed by order of commission as follows: *Cotton-tail rabbit* in Richmond County, Oct. 1–Nov. 14 and Jan. 1–Jan. 31, and in Rockland County, Oct. 1–Oct. 31 and Jan. 1–Jan. 31. *Varying hares* in Cattaraugus, Oct. 1, 1918; in Rockland, Oct. 1–Oct. 31 and Jan. 1–Jan. 31. *Black, gray, and fox squirrels* and *ruffed grouse* in Genesee, Oct. 1, 1918. *Phcasants* in Chemung, Delaware, Erie, Essex, Franklin, Genesee, Herkimer, Lewis, Montgomery, Oneida, Otsego, Putnam, St. Lawrence, Schoharie, Ulster, and Warren, Oct. 1, 1918; in Sullivan, Oct. 1, 1919.

Open seasons—Continued.

Pheasants, males only [1]	Oct. 18, Oct. 25. Nov. 3, Nov. 10.
Waterfowl, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, snipe, yellowlegs, rail	Sept. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 15.

No open season: Elk, moose, caribou, antelope, female deer and fawns, Hungarian or European gray-legged partridge, dove, and quail (1918).

Hunting licenses: Nonresident or alien, $10.50; resident, $1.10. Issued by county, city, and town clerks. No license required of owner, members of immediate family, or tenants actually occupying cultivated farm land to hunt thereon. Licensee required to wear button.

Bag limits: Two deer, 20 woodcock, 20 grouse, 3 male introduced pheasants a season; 6 varying hares or rabbits, 5 squirrels, 4 woodcock, 4 grouse, 25 waterfowl (limit for one boat or battery, 40), 15 rails, coots, mud hens or gallinules (limit for one blind, 20), 15 shore birds (limit for one blind, 25) a day.

Possession: *Waterfowl,* September 16–January 20; *deer, quail, grouse, pheasant, woodcock* during open season and 5 days thereafter. Deer properly tagged may be possessed under $1 permit to February 1.

Sale: Sale prohibited of all game birds belonging to a family any species or subspecies of which is native to and protected by the State.

Permitted: Varying hares and rabbits legally taken in State during open season (from without State at any time), and unplucked carcasses of pheasants, Scotch grouse, European gray-legged partridge, European black game, European black plover, red-legged partridge, and Egyptian quail, and carcasses of European red deer, fallow deer, roebuck, and reindeer imported from without the United States may be sold under license at any time when duly tagged.

Licensed breeders in States having laws similar to the game breeding law of New York may import for sale, under $5 license and cost of inspection, domesticated American elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, and mallard and black ducks, when duly tagged.

Head, hide, and feet of quadrupeds legally taken and possessed may be sold at any time.

Export: Export of game and birds prohibited, except any person may export 1 deer and one day's bag limit of other game in one day during open season by means other than common carrier or parcel post. The taker may export in one day by common carrier, except parcel post, one day's limit when accompanied by permit which shall show contents of package. Head, hide, and feet of animals and plumage or skin of game birds legally taken may be exported at any time.

Miscellaneous: Hunting prohibited on lands supplying any municipality with water or on public highways, except public highways within forest preserve counties.

NEW YORK—Long Island.

Open seasons:

Varying hare, rabbit (cottontail), squirrel (black, gray, fox), quail, pheasants (males only), grouse	Nov. 1–Dec. 31.
Waterfowl	Oct. 1–Jan. 15.
Coot, mud hen, gallinule	Oct. 1–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Wilson snipe or jacksnipe	Oct. 1–Nov. 30.
Woodcock	Oct. 15–Nov. 30.
Rail	Sept. 16–Nov. 30.

No open season: Deer and dove.

Bag limits and possession: Forty quail, 15 ruffed grouse, 30 male pheasants a season; 6 quail, 2 ruffed grouse, 4 male pheasants a day. For other bag limits see New York.

Hunting licenses, sale, export, miscellaneous: (See New York.)

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[1] Open season on upland game fixed or closed by order of commission as follows: *Cotton-tail rabbit* in Richmond County, Oct. 1–Nov. 14 and Jan. 1–Jan. 31, and in Rockland County, Oct. 1–Oct. 31 and Jan. 1–Jan. 31. *Varying hares* in Cattaraugus, Oct. 1, 1918; in Rockland, Oct. 1–Oct. 31 and Jan. 1–Jan. 31. *Black, gray, and fox squirrels* and *ruffed grouse* in Genesee, Oct. 1, 1918. *Pheasants* in Chemung, Delaware, Erie, Essex, Franklin, Genesee, Herkimer, Lewis, Montgomery, Oneida, Otsego, Putnam, St. Lawrence, Schoharie, Ulster, and Warren, Oct. 1, 1918; in Sullivan, Oct. 1, 1919.

NORTH CAROLINA.

(1917 laws not received.)

Open seasons: [1]

Deer	Oct. 1–Feb. 1.
Quail, wild turkey, dove	Nov. 1–Mar. 1.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Nov. 1–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Nov. 1–Dec. 31.
Rail	Sept. 1–Nov. 30.

Hunting licenses: Nonresident (Audubon), $10.25, good only in 32 counties not covered by the following or by local licenses. Nonresident (special)[2], $10.50, good only in county of issue. Issued by clerk of superior court.

Bag limits: Beaufort, quail, ruffed grouse, 15 a day combined; Brunswick, New Hanover, Pender, 15 marsh hens a day; Buncombe, 2 deer a season, 25 partridges, pheasants, wild turkeys, or doves a day; Cabarrus, Mecklenburg, 15 quail (partridges) a day; Clay, 20 quail a day; Cleveland, 10 quail (partridges) a day; Craven, 10 squirrels a day; Dare, 5 deer a season; Haywood, 1 buck a day, 2 a season; 1 pheasant, 1 wild turkey, 15 other birds a day; Henderson, Jackson, 2 bucks a season; Lenoir, 25 quail a day for individual or party; Lincoln, 10 quail a day; Madison, 25 birds a day; Robeson, 12 quail, doves, snipe, ducks a day; Transylvania, 3 deer a season, 5 squirrels, 20 quail (partridges) a day; Vance, 15 game birds a day.

Sale: The sale of game is prohibited by local laws as follows: *Deer,* Carteret (Newport Township), Craven (to Mar. 5, 1923), Cherokee, Haywood; *squirrel,* Avery (gray or pine squirrel), Craven (to Mar. 5, 1923), Madison, Pender (Rocky Point Township), Transylvania (more than 2 a day), Warren; *quail,* Alamance (to Mar. 8, 1917), Alexander, Anson, Avery, Beaufort, Bladen, Chatham, Cherokee, Clay, Craven (to Mar. 5, 1923), Cumberland, Davidson, Davie, Duplin (outside of county), Guilford, Henderson (for export), Macon, Madison, Montgomery, Moore, Pasquotank, Pender (Rocky Point Township), Pitt, Randolph, Robeson, Rowan, Rutherford, Sampson (for resale or export), Union, Wake, Warren, Wayne, Wilkes, Wilson, Yadkin (outside of county); *duck,* Robeson, Warren; *other game birds,* Avery (lark), Beaufort (pheasant—more than 15 a day), Bladen (wild turkey), Brunswick, New Hanover, and Pender (snipe, woodcock, wood duck), Cherokee (pheasant, dove, robin, woodcock, snipe), Craven (wild turkey, dove, woodcock, snipe), Cumberland (woodcock and snipe), Madison (pheasant), Montgomery (pheasant, turkey), Moore (turkey), Pender (Rocky Point Township)—turkey, dove, robin, woodcock), Robeson (dove, robin, woodcock, snipe), Union (dove, lark), Wake (turkey), Warren (turkey, woodcock), Wayne (snipe, woodcock), Wilkes (pheasant), Durham, Orange, and Person prohibit the sale of quail, except by person killing them on his own land; Harnett and Iredell prohibit the sale of quail except during open season by person killing them on his own land; Surry prohibits the sale of quail, except in county by person killing them on his own land or on lands of another under written permission; Vance prohibits the sale of quail, wild turkey, woodcock, and other game birds, except by landowner, tenant, or member of family killing such game on his own land.

Export: The export is prohibited of quail, partridge, pheasant, grouse, wild turkey, snipe, shore or beach birds, woodcock, taken in State.

Exceptions: Nonresident may take out of State under his hunting license 50 quail (partridges), 12 grouse, 2 turkeys, and 50 beach birds or snipe in a season. Export permitted under permit of Audubon Society of ruffed grouse, wild turkey, woodcock, snipe, and other shore birds, for propagation.

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[1] *North Carolina:* For county seasons see special poster of the Biological Survey, U. S. Department of Agriculture.

[2] Issued in the following 58 counties: Beaufort, Bertie, Cabarrus, Camden, Carteret, Caswell, Catawba, Cherokee, Chowan, Clay, Cleveland, Currituck, Dare, Davidson, Davie, Duplin, Forsyth, Franklin, Gaston, Gates, Graham, Granville, Halifax, Harnett, Henderson, Hertford, Hyde, Jackson, Johnston, Jones, Lincoln, Macon, Madison, Martin, Mitchell, Montgomery, Nash, Pamlico, Pasquotank, Pender, Perquimans, Pitt, Polk, Randolph, Richmond, Sampson, Stanly, Stokes, Swain, Transylvania, Tyrrell, Union, Vance, Washington, Wayne, Wilkes, Wilson, Yadkin. Special license provisions are in force in Alexander, Caswell, Clay, Craven, Dare (wild fowl), Haywood, Hoke, Jackson, Lincoln, Northampton, Onslow, Pamlico, Pender, Robeson, Warren, and Yancey Counties. Details of these are given in poster No. 36, copies of which may be had free on application to the Biological Survey, U. S. Department of Agriculture.

Export—Continued.

Export is also prohibited by the following local laws (from county unless otherwise stated): *Deer,* Cherokee, Craven, Hyde (Currituck Twp.); *squirrel,* Craven, Madison, Warren; *quail,* Alamance and Alexander (for sale), nonresident licensee may export 50 at a time; Anson (for sale), Avery, Bladen (for sale), Catawba, Chatham (for sale), Cherokee, Clay, 25 a season may be exported, Craven, Cumberland, Davidson (for sale), Davie (for sale), Duplin (for sale), Guilford (for sale), Harnett, Henderson (bought or sold), Hoke, Iredell, Jackson, Macon (for sale), Madison, Montgomery (for sale), Pitt, Randolph (for sale), Robeson, Rutherford, Sampson (for sale), Stanly, Surry (for sale), Swain (live), Union (for sale), Warren, nonresident licensee may export 25 quail and 1 turkey a season; Wayne, Wilson, nonresident may take out quail killed on own land if not for sale; Yadkin (for sale); *wildfowl,* Avery, Craven (from State), Brunswick (Mar. 10–Nov. 10), Dare (Mar. 10–Nov. 10), New Hanover (Mar. 10–Nov. 10), Robeson, Stanly, Warren (duck); *other game birds,* Bladen (wild turkey, for sale); Cherokee (pheasant, dove, woodcock, snipe, robin); Craven (wild turkey, dove, woodcock, snipe); Cumberland (woodcock, snipe); Madison (pheasant), Montgomery (pheasant, grouse, wild turkey, dove, for sale); Robeson (dove, woodcock, snipe); Stanly (all game birds), Tyrrell (woodcock, snipe, from State, unless killed Nov. 1–Feb. 1); Union (dove, lark for sale); Warren (wild turkey, except that one a season may be exported by nonresident licensee, woodcock); Wayne (woodcock, snipe).

NORTH DAKOTA.

Open seasons:

Prairie chicken (pinnated grouse), sharp-tailed (white-breasted) grouse, black-bellied and golden plovers, yellowlegs, Wilson snipe	Sept. 16–Oct. 16.
Ruffed grouse in Bottineau, Cavalier, Pembina, and Roulette Counties only	Oct. 1–Oct. 10.
Duck, goose, brant, coot, gallinule	Sept. 7–Dec. 20.
Woodcock	Oct. 1–Oct. 16.
Rail	Sept. 1–Nov. 30.

No open season: Deer (1920); elk, moose, antelope, quail, ruffed grouse (except as above), English and Chinese ringneck pheasants, Hungarian partridge, dove.

Hunting licenses: Nonresident, $25; resident, $1. Issued by commissioners, deputy, or county auditor. Aliens not permitted to hunt. No license required of person or member of family permanently residing with him to hunt on own lands or lands cultivated by him. Resident license may be issued to settler. No person permitted to enter cultivated or posted lands without consent of owner.

Bag limits and possession: Five prairie chickens, sharp-tailed grouse, plover, each or all combined a day, 10 each or all in possession at one time; 5 ruffed grouse a day, 15 in possession; 15 snipe, woodcock, rail, ducks, geese, each or all combined, 30 in possession. Resident licensee under permit may retain not to exceed 20 pinnated or sharp-tailed grouse, 30 waterfowl, but not more than 50 birds in all during first 5 days of close season.

Sale: Sale of all protected game prohibited. Hides, heads, and trophies of big game lawfully taken may be sold at any time.

Export: Export of all protected game prohibited, except nonresident licensee may carry with him from State under license tag prairie chickens and sharp-tailed grouse not exceeding 20 in all, and ducks, geese, and brant not exceeding 30 in all, or a total of 50 of all birds combined, if open to view and labeled with his name and address and number of his license. Board may grant permits for the export of live game.

OHIO.

Open seasons:

Rabbit	Nov. 15–Jan. 1.
Squirrel	Sept. 15–Oct. 20.
Raccoon, opossum	Nov. 15–Feb. 1.
Ruffed grouse, introduced pheasant, Hungarian partridge	Nov. 15–Dec. 4.
Duck, goose, brant, Wilson snipe	Sept. 16–Dec. 15.[1]
Coot, gallinule	Sept. 16–Nov. 30.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Oct. 1–Nov. 30.
Rail	Sept. 1–Nov. 30.

[1] *Ohio:* Sundays and Mondays are close seasons for ducks and other waterfowl.

No open season: Quail, dove.

Hunting licenses: Nonresident citizen, $15.25; resident citizen, $1.25. Issued by county and town clerks. Person under 16 when hunting must be accompanied by adult. No license required of owner, tenant, or their children to hunt on own or leased lands. Badge must be worn by hunter. Written permission required on land of another.

Bag limits: Five squirrels, 10 rabbits, 12 each of plover, yellowlegs, snipe, woodcock, rail, geese, 25 ducks a day.

Sale: Sale prohibited of all protected game (except rabbit).

Export: Export prohibited of all protected game (except rabbits) taken in State, provided, a nonresident may take with him from State under his hunting license 25 pieces of game. Packages containing game must be marked to show contents.

OKLAHOMA.

Open seasons: [1]

Quail	Dec. 1–Dec. 31.
Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule	Oct. 16–Jan. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Dec. 15.
Woodcock	Nov. 1–Dec. 31.
Rail	Sept. 1–Nov. 30.

No open season: Deer (1922), antelope, prairie chicken, imported pheasant, wild turkey.

Hunting licenses: Nonresident, $15; alien, $25; resident citizen, $1.25. Issued by warden, deputy, or county clerk. No license required of person to hunt on own or leased premises actually occupied by him. Application of person under 14 must be approved in writing by parent or guardian. Unlawful to shoot on or across highway or railroad right of way. Unlawful to hunt on lands of another without owner's permission.

Bag limits: Fifteen quail, plover, snipe, or ducks a day, 100 a season; 10 geese or brant a day.

Sale: Sale prohibited of all protected game, except the heads, hides, and horns of big game lawfully killed may be sold.

Export: Export prohibited of all protected game, except nonresident licensee may carry to his home two days' bag limit of game birds, if license permit is attached.

OREGON.[2]

Open seasons:

District No. 1,[3] west of Cascades:

Deer (male, with horns)	Aug. 15–Oct. 15.
Silver-gray squirrel, dove	Sept. 1–Oct. 31.
Quail in Coos, Curry, Jackson, and Josephine Counties only	Oct. 1–Oct. 31.
Grouse, male Chinese pheasant (see exceptions)	Oct. 1–Oct. 31.
Exceptions: Grouse and male Chinese pheasant in Jackson County	Oct. 1–10
Chinese pheasants in Coos, Curry, and Josephine Counties	No open season.
Duck, goose, brant, Wilson snipe, coot	Oct. 1–Jan. 15.
Black-bellied and golden plovers, yellowlegs	Oct. 1–Dec. 15.
Rail	Oct. 1–Nov. 30.

District No. 2, east of Cascades:

Deer (male, with horns) (see exception)	Sept. 1–Oct. 31.
Exception: In Harney and Malheur Counties	Aug. 15–Oct. 15.
Male Chinese pheasants in Union County and quail in Klamath County	Oct. 1–Oct. 10
Ruffed grouse, native pheasant, blue or sooty grouse	Aug. 15–Oct. 31.
Prairie chicken in Sherman, Union, and Wasco Counties only	Oct. 1–Oct. 15.

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[1] *Oklahoma:* Bear in Blaine, Caddo, Comanche, Kiowa, and Major Counties, no open season; in balance of State, unprotected.

[2] *Oregon* Governor may suspend open season in time of drought.

[3] District No. 1, west of Cascades, includes Benton, Clackamas, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties. District No. 2, east of Cascades, includes all other counties in the State.

Open seasons—Continued.

Sage hen (see exception)—Aug. 1–Aug. 31.
Exception: In Harney and Malheur Counties—Aug. 1–Sept. 15.
Dove (see exception)—Sept. 1–Oct. 31.
Exception: In Harney and Malheur Counties—Aug. 1–Sept. 30.
Duck, goose,[1] brant, Wilson snipe, coot—Oct. 11–Jan. 15.[2]
Black-bellied and golden plovers, yellowlegs—Oct. 1–Dec. 15.
Rail—Oct. 1–Nov. 30.

No open season: Doe and spotted fawn, moose, elk, antelope, caribou, sheep, goat, Hungarian partridge, bobwhite, prairie chicken, Franklin grouse, fool hen, wild turkey; silver gray squirrel, quail, and introduced pheasants (except as above).

Hunting and fishing licenses: Nonresident, all game, $10; alien, gun license fee $25 (in addition to hunting and angling license); issued by commissioners; resident, all game, $1.50. Angling, resident or nonresident, $1.50 (not required of females); issued by county clerks. Licenses not issued to persons under 14 years of age, who may hunt with gun on own premises or those of parent, relatives, or guardian only. Unlawful to hunt with dog or gun on cultivated or inclosed land of another without permission of owner, occupant, or agent. Licenses issued free of charge to pioneers of State who arrived prior to 1860 and veterans of Indian and Civil Wars upon proof of service.

Bag limits and possession: Two deer a season; 5 silver gray squirrels and 10 quail in 7 consecutive days; 5 sage hens a day, 10 in 7 consecutive days in district 2, except in Harney and Malheur Counties, the limit is 15 in 7 consecutive days; 5 ruffed grouse, pheasants, sooty or blue grouse, sage hens, prairie chickens, and Chinese pheasants (only 1 of which may be a female) a day, 10 in 7 consecutive days; 10 doves (State) a day, 20 in 7 consecutive days; 30 shore birds, rails, coots, ducks, and geese in 7 consecutive days. Game properly tagged may be possessed during close season.

Sale: Sale of all protected game prohibited, except geese killed in Crook, Gilliam, Harney, Morrow, Sherman, Umatilla, and Wasco Counties may be sold during open season when duly tagged. Game birds and animals imported from without the United States, when duly tagged, may be sold September 1 to March 1. Tag fee, 5 cents each. Commissioners may make regulations permitting the sale of game.

Export: Export of all protected game is prohibited.

PENNSYLVANIA.

Open seasons:[3]

Deer—male with horns 2 inches above the hair—Dec. 1–Dec. 15.
Bear—Oct. 15–Dec. 15.
Hare, rabbit—Nov. 1–Dec. 15.
Squirrel (gray, black, fox), quail, ruffed grouse, ringneck pheasant, Hungarian partridge, woodcock—Oct. 20–Nov. 30.
Wild turkey—Nov. 15–Nov. 30.
Duck, goose, brant, loon, grebe—Oct. 1–Jan. 15.[4]
Black-bellied and golden plovers, yellowlegs—Sept. 1–Nov. 30.
Wilson snipe or jacksnipe, coot, mud hen, gallinule—Oct. 1–Nov. 30.
Reedbird—Sept. 1–Oct. 31.
Rail, blackbirds—Sept. 1–Nov. 30.

No open season: Elk (1921), doe, fawn, dove.

Hunting licenses: Nonresident, $10. Issued by commission or county treasurer. Resident, $1 from county treasurer, $1.15 from justice of the peace. Licenses not issued to minor under 14 years of age, and minor under 16 must furnish written consent of parent or guardian. Licensee required to wear tag.

Resident citizen and members of family residing upon and cultivating land in State may hunt on such land and, with consent of owner, on adjoining land without a license. Aliens not permitted to hunt.

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[1] *Oregon:* Unlawful to kill geese at any time on islands or sand bars in the Columbia east of the Cascades or on Deschutes and John Day Rivers south to junction with White River and Thirtymile Creek, respectively.

[2] Under an amendment of the Federal Regulations, approved by the President on October 10, 1917, the season on waterfowl, coot, and gallinules is closed on December 31 in eastern Oregon.

[3] *Pennsylvania:* Seasons may be closed by order of commission.

[4] Under an amendment of the Federal Regulations, approved by the President on October 10, 1917, the season on waterfowl, coot, and gallinules is closed on December 31.

Bag limits and possession: One deer (6 to body of men either camping or hunting in unison), 1 bear (3 to body of men either camping or hunting in unison), 60 rabbits, 15 hares, 20 squirrels, 1 turkey, 25 quail (Virginia partridge), 24 ruffed grouse, 10 ring-necked pheasants, 10 Hungarian quail, 20 woodcock a season. Ten rabbits, 3 hares, 6 squirrels, 8 quail (Virginia partridge), 4 ruffed grouse, 4 ring-necked pheasants, 4 Hungarian quail, 10 woodcock a day. Possession permitted during open season and for 30 days thereafter.

Sale: The sale is prohibited of wild deer, elk, squirrel, rabbit or hare, wild ring-necked pheasant, and Hungarian partridge taken in the State; and of quail, ruffed grouse (pheasant), wild turkey, and woodcock (wherever taken). Provided, bear, blackbirds, reedbird, black-bellied and golden plovers, Wilson or jacksnipe, yellowlegs, coot or mud hen, rail, taken in State, may be sold during open season and 30 days thereafter; waterfowl may be sold September 1 to January 1. Belgian and German hares may be sold at any time.

Export: The export is prohibited of all protected game, except a nonresident licensee may take out with him on the same conveyance one day's limit of game. Small game to be carried upon the person in hunting coat or game bag, or as hand baggage, without cover. Packages containing large game to be plainly marked.

Miscellaneous: Use of automatic guns prohibited.

RHODE ISLAND.

Open seasons:

Gray squirrel, hare, rabbit, quail or bobwhite, ruffed grouse or partridge, pheasant	Nov. 1–Dec. 31.
Duck, goose, brant, coot, gallinule	Oct. 1–Jan. 15.
Black-bellied and golden plovers, yellowlegs	Aug. 16–Nov. 30.
Wilson snipe	Oct. 1–Nov. 30.
Woodcock	Nov. 1–Nov. 30.
Rail	Sept. 1–Nov. 30.

No open season: Deer,[1] dove, Hungarian partridge (1920).

Hunting licenses: Nonresident, $10.15; alien, $15.15; resident, $1.15. Issued by city and town clerks.

Not required of resident or his immediate family to hunt on own or leased agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than $500, and nonresident member of club incorporated for hunting or fishing purposes prior to Jan. 1, 1909, which owns real estate assessed for taxation at value of not less than $1,000, may procure license at a fee of $1.15; licenses not issued to minors under 15 years of age. Consent of owner required for hunting on land of another from Oct. 15–Dec. 15.

Bag limits: None prescribed.

Sale: Prohibits sale of ruffed grouse (partridge), quail, and woodcock wherever taken or killed.

Export: Export of all game prohibited, except that nonresident licensee may take out under his license 10 wild fowl or birds in one calendar year, if carried open to view.

SOUTH CAROLINA.

Open seasons:

Deer (see exceptions)	Sept. 1–Jan. 1.
Exceptions: In Berkeley, Clarendon, and Dorchester Counties	Aug. 1–Feb. 1.
In Barnwell, Dillon, Florence, and Marion	Aug. 1–Jan. 1.
In Colleton	Sept. 1–Feb. 1.
In Georgetown	Oct. 1–Jan. 15.
In Jasper and Hampton	Aug. 15–Jan. 15.
In Richland	1921
Squirrel in Chesterfield and York Counties	Oct. 1–Jan. 1.
Quail (partridge), wild turkey (see exceptions)	Nov. 15–Mar. 15.
Exceptions: Quail—In Abbeville and Chesterfield Counties	Nov. 15–Mar. 1.
In Charleston	Nov. 20–Feb. 15.
In Cherokee	No open season.[2]

[1] *Rhode Island:* Deer injuring crops may be killed at any time by the owner or occupant of the premises under written permit from secretary of state.

[2] *South Carolina:* Quail may be hunted in Cherokee County by landowner or by his written permit on his own land from Dec. 16 to Jan. 14, inclusive.

Open seasons—Continued.
Quails and wild turkey—Continued.
Exceptions—Continued.
Quail in Chester, Lancaster, and York—Dec. 1–Feb. 1.
In Fairfield and Union—Dec. 1–Mar. 1.
In Greenwood—Nov. 15–Jan. 15.
In Marlboro—Nov. 15–Feb. 15.
Wild turkey in Abbeville, Chester, Lancaster, and York—Dec. 1–Feb. 1.
In Fairfield—Dec. 1–Mar. 1.
Dove (see exception)—Aug. 15–Mar. 1.
Exception: In Kershaw—Aug. 15–Mar. 15.
Duck, goose, brant, black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs, coot, gallinule—Nov. 1–Jan. 31.
Woodcock—Nov. 1–Dec. 31.
Grackle—Oct. 1–Mar. 1.
Reedbird—Sept. 1–Oct. 31.
Rail—Sept. 1–Nov. 30.

Hunting licenses: Nonresident, $15.25, issued by county clerk. Resident, State, $3; county of residence, $1.10. Issued by county clerk or game warden.

No license required of resident owners, tenants, and their children on own lands, or on public lands and waters in county of residence, or of persons to hunt on land of another in county of residence with written permission of owner.

Unlawful to hunt on land of another without consent of owner.

No resident license required in counties of Aiken, Berkeley, Cherokee, Chesterfield, Clarendon, Colleton, Georgetown, Greenwood, Jasper, Lancaster, Marlboro, Williamsburg, and York, or in townships of Bluffton and Yemassee in Beaufort County.

Bag limits: Five deer a season, 25 quail (partridge), 25 doves, 12 woodcock, 2 turkeys a day; 15 quail in Charleston County a day.

Sale: Sale prohibited of deer, quail (partridge), turkey, dove, and woodcock. Sale permitted of ducks and rice birds.

Export: Export prohibited of all protected game taken in State; provided, a nonresident licensee may export 2 deer, 50 quail, 12 ruffed grouse, 4 turkeys, 50 in all of plover, yellowlegs, and snipe, 50 waterfowl if not for sale and packages are marked to show contents.

SOUTH DAKOTA.

Open seasons:
Deer—Nov. 1–Nov. 30.
Partridge, grouse, prairie chicken, golden plovers, yellowlegs—Sept. 7–Oct. 6.
Duck, goose, brant, Wilson snipe, coot, gallinule—Sept. 7–Dec. 20.
Woodcock—Oct. 1–Nov. 30.
Rail—Sept. 1–Nov. 30.

No open season: Fawns, elk, antelope, mountain sheep, quail, dove, introduced pheasants.

Hunting licenses: Nonresident: Big game, $25; small game, $15; issued by game warden or county treasurer. Resident: Big game (good only in county of issue), $5; small game, $1; issued by county treasurer. Hunting on own land permitted without license.

Bag limits and possession: One deer a year; 15 ducks or other aquatic fowl and 5 of each other species of game birds a day; 35 ducks, geese, or brant, or other aquatic fowl, and 15 prairie chickens, grouse, and plover in possession. Possession permitted during open season and five days thereafter.

Sale: The sale of all protected game is prohibited; provided, skins, heads, and antlers of deer lawfully killed may be sold.

Export: Export prohibited of all protected game; provided, a nonresident may export 1 deer lawfully killed under permit of State game warden and not more than 10 birds under each of five tags attached to his license.

TENNESSEE.

Open seasons:
Deer (see exception)—No open season.
Exception: In Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties—Nov. 1–Dec. 10.
Squirrel (see exceptions)—June 2–Dec. 31.
Exceptions: In Bledsoe, Cannon, Cumberland, Grundy, Lincoln, Marion, Sequatchie, Sumner, and Van Buren Counties unprotected; in Dickson, June 1–Nov. 1; in Dyer, June 1–July 1 and Oct. 1–Jan. 1; in Fayette, Rutherford, June 1–Jan. 1; in Smith and Wilson, May 1–Mar. 1; in Warren, Nov. 1–Mar. 1.

Open seasons—Continued.

Rabbit (see exception)——Unprotected.

Exception: In Carter, Dec. 1–Mar. 1; in Johnson, Nov. 15–Feb. 1.

Quail or partridge, wild turkey (additional season for gobblers, Apr. 2–24) (see exceptions)——Nov. 16–Dec. 31.

Exceptions: Quail, in Bedford, McMinn, Monroe, Moore, and Obion Counties, Dec. 1–Jan. 1; in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren, Nov. 1–Jan. 1; in Bradley, Campbell, Carter, Henry, and Montgomery, Dec. 1–Feb. 1; in Carroll, Dec. 1–Jan. 31; in Cannon and White,, Nov. 15–Feb. 15; in Crockett, Rutherford, and Sumner, Nov. 15–Jan. 1; in Dickson and Johnson, Nov. 15–Jan. 15; in Dekalb, Nov. 15–Feb. 1; in Fayette, Nov. 22–Mar. 5; in Hardeman, Dec. 15–Mar. 1; in Henderson and Weakley, Dec. 15–Feb. 15; in Hickman, Dec. 1–Jan. 15; in Lincoln, Dec. 1–Feb. 15; in McNairy, Dec. 15–Feb. 1; in Sullivan, Nov. 20–Feb. 15; in Washington, Nov. 20–Jan. 1. Season closed in Greene until Nov. 15, 1922, and in Unicoi until May 15, 1918.

Wild turkey, in Bledsoe, Cumberland, Grundy, Marion, Sequatchie, and Van Buren Counties, Nov. 1–Jan. 1, and also on gobblers only, Apr. 1–May 1; in Lincoln, Nov. 1–Mar. 1, and also on gobblers only, Apr. 1–Apr. 25; in Cannon and Sullivan, unprotected. Season closed in Unicoi until May 15, 1918.

Dove (see exceptions)——Aug. 16–Dec. 31

Exceptions: In Carter, Nov. 1–Feb. 1; in Fayette, July 1–Nov. 1; in Lincoln, Sept. 1–Feb. 15; in Montgomery, Sept. 1–Dec. 1; in Obion, Aug. 15–Sept. 15; in Rutherford, Aug. 15–Jan. 1; in Sullivan, Nov. 20–Feb. 15; in Sumner, Aug. 1–Jan. 1; in Unicoi, May 15, 1918.

Duck, goose, brant, coot, mud hen, gallinule, Wilson or jacksnipe——Nov. 1–Jan. 31.

Black-bellied and golden plovers, yellowlegs——Sept. 1–Dec. 15.

Rail——Sept. 1–Nov. 30.

No open season: Deer (1919), grouse, ring-necked and Mongolian pheasants, and woodcock.

Hunting licenses: Nonresident: $10 (may hunt on own land without license). Resident: State, $2; county, $1 (county licensee may obtain State license for $1). Issued by county clerks. County license not required of residents in Cannon, Hardin, Houston, and Jackson Counties, or of residents to hunt squirrels in Dyer, Lincoln, Smith, Wagner, and Wilson Counties.

Owners and tenants may hunt without license on land on which they reside. Unlawful to hunt on tillable or inclosed lands of another without written permission.

Reelfoot Lake: State license required of residents to hunt thereon. Nonresident, fish, $2. Guide or pusher, $1.

Bag limits and possession: Twenty game birds and animals a day, except in Carter County, quail, 20 in possession; in Lauderdale County, 6 squirrels, 12 quail, and 2 turkeys a day or in possession.

Sale: Sale prohibited of protected birds killed in State.

Export: Export of all protected game prohibited, except nonresident licensee may take out of State, if carried openly, game birds legally killed by him.

TEXAS.

Open seasons:

Deer (male)——Nov. 1–Dec. 31.

Quail or partridge——Dec. 1–Jan. 31.

Prairie chicken, pinnated grouse, introduced pheasant——Nov. 1–Jan. 31.

Wild turkey——Dec. 1–Mar. 31.

Dove——Sept. 1–Feb. 28.

Duck, goose, brant, Wilson snipe or jacksnipe, coot, gallinule——Oct. 16–Jan. 31.

Black-bellied and golden plovers, yellowlegs——Nov. 1–Jan. 31.

Woodcock——Nov. 1–Dec. 31.

Rail——Sept. 1–Nov. 30.

No open season: Does, spotted fawns, antelope, sheep, goats (1942).

Hunting licenses: Nonresident, $15; issued by game, fish, and oyster commissioner. Resident, $1.75, not required in county of residence and contiguous counties or on land owned or controlled; issued by commissioner and county clerks.

Bag limits: Three deer a season, 3 wild turkeys December 1 to March 1, 15 other birds a day.

Sale: Sale prohibited of all protected game.

Export: Export prohibited of all game, except nonresident licensee may export 3 male deer in open season; 75 ducks and 25 other birds may be exported if accompanied by owner and affidavit of lawful killing and that game is not for sale.

UTAH.

Open seasons:

Duck, goose, Wilson snipe, coot, gallinule	Oct. 1–Dec. 31.
Rail	Sept. 1–Nov. 31.

No open season: Male deer (1920), does, fawns, elk, antelope, sheep, quail, partridge, prairie chicken, blue grouse, sage hens, pheasants, dove, shore birds (except snipe).

Hunting licenses: Nonresident citizen, over 14 years, game and fish, $6; resident (male), game and fish, $1.25. Aliens prohibited from hunting or fishing in State. Residents under 14 not required to secure license, and any person may kill rabbits without a license. Issued by State game and fish commissioner or deputy, county clerk or deputy.

Bag limits: Six geese a day or 25 ducks, geese, and Wilson snipe in any one day.

Sale: Sale prohibited of all game except waterfowl.

Export: Export of all game prohibited, except nonresident licensee may take out one day's limit of game by permission of commissioner after being inspected and properly marked.

VERMONT.

Open seasons:

Deer (with horns not less than 3 inches in length)	Nov. 10–Nov. 20.
Hare, rabbit	Sept. 15–Feb. 28.
Gray squirrel, quail, ruffed grouse (partridge)	Sept. 15–Nov. 30.
Ducks, goose, brant, coot, gallinule	Sept. 16–Dec. 31.
Black-bellied and golden plovers, yellowlegs	Sept. 1–Nov. 30.
English or Wilson snipe (jacksnipe)	Sept. 16–Nov. 30.
Woodcock	Oct. 1–Nov. 30.

No open season: Elk (1923), moose, caribou, does, fawns, pheasants, European partridge, dove, rail.

Hunting and fishing licenses: Nonresident: Game and fish, $10.50; owner of real estate in State to value of $1,000, $1; fish, $2. Resident: Game and fish, $1; game, 60 cents; fish, 60 cents. Issued by town clerks.

Hunting licenses not issued to persons under 16 without written consent of parent or guardian. No license required of owners of farm lands, their resident minor children, or tenants on own lands. Fishing licenses not required of persons under 16 or of women.

Bag limits: One deer, 25 ruffed grouse, 25 woodcock a season; 5 hares or rabbits, 5 squirrels, 4 quail, 4 ruffed grouse, 4 woodcock, 10 English snipe, 10 plover, 10 yellowlegs, 20 ducks, and 20 geese a day.

Sale: Sale prohibited of all protected game birds or species belonging to any family native of the State; deer may be sold during open season and for a "reasonable time thereafter," and hares and rabbits during the open season.

Export: Export prohibited of all protected game, except hares and rabbits, provided, a nonresident licensee may export one deer and one day's bag limit of game birds under permit, but must accompany shipment; resident may export (if not for sale) one day's bag limit of game birds under special permit from commissioner.

VIRGINIA.

Open seasons: [1]

Deer (see exceptions)	Sept. 1–Dec. 1.
Exceptions: In Chesterfield, Mecklenburg, Prince George, and Surry	Oct. 1–Jan. 1
In Brunswick and Greenesville	Oct. 1–Feb. 1.
In Augusta and Cumberland (1919); Bath, Buckingham, and Highland (1921); Shenandoah (1920).	
Rabbit [2]	Nov. 1–Feb. 1.

[1] *Virginia:* Boards of supervisors may shorten the open season in their counties and make other restrictions not repugnant to law, "and may include in such protection other game not specifically mentioned in this section." (Code 1904, sec. 2070a, as amended in 1906.) These changes are not included in this table.

[2] Residents of the State may kill rabbits on their own lands at any time.

Open seasons—Continued.

Squirrel,[1] in Brunswick, Caroline, Charles City, Greenesville, James City, New Kent, Spotsylvania, Stafford, Warwick, and York Counties—Nov. 1–Feb. 1.
In Isle of Wight and Southampton—Sept. 1–Jan. 15.
In Shenandoah—Aug. 15–Oct. 1.
In Warren—Nov. 15–Jan. 1.
In balance of State—Unprotected.

Quail or partridge, pheasant or grouse, wild turkey (see exception)—Nov. 1–Feb. 1.
Exception: West of the Blue Ridge—Nov. 1–Dec. 31.

Dove, in Brunswick and Greensville Counties—Aug. 15–Jan. 15.

Duck, goose, brant,[2] Wilson snipe or jacksnipe, coot, mud hen, gallinule—Nov. 1–Jan. 31.

Black-bellied and golden plovers, yellowlegs—Aug. 16–Nov. 30.

Woodcock—Nov. 1–Dec. 31.

Rail—Sept. 1–Nov. 30.

Reedbird—Sept. 1–Oct. 31.

No open season: Quail, pheasant, dove in Lee County (1918); pheasant, Middlesex County (1919); ring-necked pheasant, Shenandoah (1920). By order of commissioner, approved by governor, introduced pheasants protected throughout State until September, 1, 1920.

Hunting licenses: Nonresident, $10; alien, $20 (alien owner of real estate resident for five years, same as resident). Resident: State, $3; county of residence, $1. Issued by clerks of circuit and of corporation courts.

No license required of nonresident owner of land to hunt thereon. Owner, members of family, and tenant of land residing thereon may hunt without license on own or adjoining lands with consent of owner.

Bag limits: Thirty-five ducks, geese, and brant a day in Back Bay, Princess Anne County; in Shenandoah County, 15 quail or partridges, 3 pheasants or grouse, and 2 wild turkeys a day.

Sale: The sale of quail or partridge, grouse or pheasant, wild turkey and woodcock is prohibited.

Export: The export of all protected game, except waterfowl legally killed, is prohibited, provided that during open season nonresident may, under his hunting license, take with him out of State, or as baggage on same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, and 25 of each or 100 in all of plover and snipe, if killed or captured by himself, shipped open to view, and plainly labeled with his name and address. Any citizen of State may ship from State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, if open to view and plainly labeled with names and addresses of donor and donee and number of each kind of bird so shipped.

Back Bay, Princess Anne County: Nonresident licensee permitted to export as personal baggage 25 ducks, geese, or brant he has lawfully killed, but not for sale or barter.

Shenandoah County: Licensee may take with him from county as personal baggage, open to view, if plainly labeled, 30 quail or partridges, 6 pheasants or grouse, 2 wild turkeys a season, and any citizen may ship the same quantity of game, as a gift, if not for sale.

WASHINGTON.

Open seasons:

West of Cascades—

Deer (see exceptions), goat—Oct. 1–Nov. 1.
Exceptions: Deer in Island and San Juan Counties, Jan. 1, 1921; does in Skagit, Snohomish, and Whatcom Counties, no open season.

Bear—Sept. 1–May 1.

Quail (see exception), ruffed grouse, native pheasant, Chinese pheasant (see exception), blue grouse, ptarmigan—Oct. 1–Oct. 15.
Exceptions: Quail in Clallam, Clarke, Jefferson, San Juan, Skagit, Skamania, Snohomish, and Whatcom, Oct. 1, 1919.
Chinese pheasants in Clallam, Kitsap, and Skamania Counties; no open season.

Duck, goose, brant, coot—Oct. 1–Jan. 15.

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[1] *Virginia:* Residents of the State may kill squirrels on their own lands at any time.

[2] Wild fowl may not be hunted on Wednesdays, Saturdays, and Sundays on Back Bay, Princess Anne County.

Open seasons—Continued.

East of Cascades—

Deer—Oct. 1–Nov. 15.
Bear—Sept. 1–May 1.
Ruffed grouse (native pheasant), blue grouse (see exception)—Sept. 1–Nov. 15.
Exceptions: In Asotin (in precincts of Clarkston, South Clarkston, and West Clakston, no open season), Garfield, and Walla Walla, Aug. 15–Oct. 1. *Ruffed grouse* in Kittitas and Yakima Counties, no open season. *Blue grouse* in Spokane County, Oct. 1, 1919.
Quail in counties of Asotin (in precincts of Clarkston, South Clarkston, and West Clarkston; no open season) and Garfield—Oct. 1–Oct. 10.
Prairie chicken in Stevens County—Sept. 15–Oct. 1.
Sharp-tailed grouse in Ferry and Okanogan Counties—Sept. 15–Nov. 1.
Sage hens, Hungarian partridges, male Chinese pheasant in Kittitas County—Oct. 1–Oct. 10.
Bobwhite quail in Spokane County—Oct. 1–Nov. 1.
Hungarian partridge in Lincoln, Spokane, and Stevens Counties—Oct. 1–Nov. 15.
Chinese pheasants in Benton, Stevens, and Yakima Counties—Oct. 1–Oct. 15.
Duck, goose, brant, coot—Oct. 1–Dec. 31.[1]

State seasons—

Black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs—Oct. 1–Dec. 15.
Rail—Sept. 16–Nov. 30.

No open season: Moose, elk (1925); fawns, caribou, mountain sheep, squirrels (gray, black, fox), quail, prairie chicken, sage hens, introduced birds (except as above), turkey, and dove.

Hunting and fishing licenses: Nonresident: General, $10; fishing, $2. Resident: State, $5, county, $1. Issued by county auditors.

No license required of honorably discharged Union soldiers of Civil War to hunt or fish, or of women and person under 16 to fish, if residents.

Bag limits: One deer in counties east of Cascades. Two deer (1 buck in Skagit, Snohomish, and Whatcom), 1 goat in counties west of Cascades.

Five in all of partridge, grouse, prairie chickens, Hungarian partridge, Chinese or English pheasant a day or in possession; 10 quail a day; 10 upland birds but in no event to exceed 5 if quail are included in bag, and 25 in all a week. In Kittitas County 2 male Chinese or English pheasants in bag of 5 upland birds; 20 ducks, geese, brant, golden plover, yellowlegs, Wilson snipe a week (week ends at midnight Saturday), 30 ducks, geese, brant in possession. Possession during close season permitted under permit.

Sale: Sale prohibited of all protected game.

Export: Export prohibited of all protected game.

WEST VIRGINIA.

Open seasons:

Deer (with horns more than 4 inches long, no open season for other deer), rabbit (except on own land), ruffed grouse (pheasant), wild turkey—Oct. 15–Dec. 1.
Squirrel (black, gray, red, fox)—Sept. 16–Nov. 30.
Quail (Virginia partridge)—Nov. 1–Dec. 1.
Duck, goose, brant—Oct. 1–Dec. 31.
Coot, gallinule—Sept. 16–Dec. 31.
Wilson snipe or jacksnipe—Oct. 15–Dec. 15.
Black-bellied and golden plovers, yellowlegs—Sept. 1–Dec. 15.
Woodcock—Oct. 1–Nov. 30.
Rail (ortolan)—Sept. 1–Nov. 30.

No open season: Elk (1923), imported pheasants, capercailzie, and other introduced foreign game birds, dove.

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[1] *Washington:* No open season on waterfowl on Columbia or Snake Rivers or within ¼ mile of their shores in counties of Benton, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Walla Walla, Whitman, and Yakima.

Hunting licenses: [1] Nonresident, $16. Resident: State, $3; county of residence, no fee, issued by county clerk. Aliens not permitted to hunt. License issued to minor under 15 on consent of parent or guardian. Unlawful to hunt on inclosed or improved lands without written permission of owner.

Bag limits and possession: Two deer a season; 12 squirrels a day, 100 a season; 12 quail a day, 96 a season; 6 ruffed grouse a day, 25 a season; 2 wild turkeys a day, 6 a season. Possession permitted during open season and first 20 days of close season.

Sale: The sale is prohibited of all protected game, except rabbit and rail may be sold during open season.

Export: Export prohibited of deer, venison, squirrel, quail, ruffed grouse (pheasant), wild turkey, woodcock, geese, brant, ducks, plover, snipe.

Miscellaneous: Unlawful to discharge firearms across any public road, within 400 feet of any schoolhouse, or on the lands of another within 600 feet of an occupied dwelling house.

WISCONSIN.

Open seasons:

Deer in Pierce, Barron, Trempealeau, Jackson, Wood, Marathon, Shawano, Oconto, and all counties north thereof.....Nov. 21–Nov. 30.
In rest of State, no open season.
Bear.....Nov. 10–Dec. 1.
Rabbit (see exceptions).....Sept. 7–Feb. 1.
Exceptions: In Clark, Green, and Wood Counties.Oct. 15–Feb. 1.
In Dane County.....Oct. 1–Mar. 1.
In Dodge, Jefferson, Kenosha, Ozaukee, Racine, Walworth, Washington and Waukesha Counties.....Nov. 1–Jan. 1.
In Columbia, Crawford, Door, Grant, Iowa, Jackson, Juneau, Monroe, Outagamie, Pierce, Polk, Richland, Rusk, Sauk, Sawyer, Sheboygan, and Winnebago Counties..Unprotected.
Squirrels (see exceptions).....Oct. 15–Jan. 1.
Exceptions: In Dodge, Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha Counties.....No open season.
Duck, coot or mud hen.....Sept. 7–Dec. 10.
Goose, brant, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs.....Sept. 7–Dec. 20.
Rail, rice hen.....Sept. 7–Nov. 30.

No open season: Elk, moose, quail, pheasants (Chinese, English, Mongolian), Hungarian partridge, woodcock, dove, swan, ruffed grouse, spruce hen, sharp-tailed grouse, prairie chicken (1919).

Hunting and fishing licenses: Nonresident: All game and fish, $50; all game (except deer) and fish, $25; fish, $1 (not required in outlying waters or of person under 16); settlers, $1; guide, $1. Issued by commissioner. Resident: Game, $1 (deer tag, 10 cents additional). Issued by county clerks.

Hunting licenses not issued to persons under 15 or to aliens, except alien settlers. Hunting prohibited on fields of growing grain or on lands of another without consent of owner.

Bag limits and possession: One deer a season; squirrels, 5 a day; rabbits, 5 to 10 a day in certain counties; other counties no limit; geese and brant, 10 a day; duck (including coot or mudhen), plover, snipe, rail, rice hen, 15 a day; mixed bag limit of 20 a day is permitted, but containing not more than the bag limit of any one variety.

Possession at any time of deer duly tagged permitted for private use by person killing it. Possession at any time prohibited of game by person without hunting license or scientist's certificate.

Sale: Sale prohibited of all protected game (except rabbit). Rabbits may be sold during open season.

Export: Export prohibited of all protected game, except nonresident licensee may transport during last 10 days of November 1 deer duly tagged if he accompanies shipment and may take in his personal possession, openly, a mixed bag of not more than 20 game birds legally killed, but not more than the bag limit for one day of any one variety.

Export permitted of specimens of birds and animals (except deer) taken under permit for scientific purposes. Park boards allowed to ship, under permit of State game warden, live animals and game birds for park purposes.

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[1] *West Virginia:* Fishing license: Nonresident, $5, issued by county clerk.

WYOMING.

Open sasons:[1]

Deer (see exception)—Oct. 1–Nov. 15.
Exception: In Campbell, Crook, Johnson, Niobrara, Sheridan, and Weston Counties—Oct. 15–Oct. 31.
Elk and male sheep in Lincoln, Park, and Fremont Counties (except Bridger National Forest and north of Big Wind River and south of Sweetwater River)—Sept. 1–Nov. 15
Grouse (other than sage grouse)—Sept. 1–Nov. 15
Sage grouse—Aug. 1–Sept. 1.
Duck, goose, coot, mudhen, black-bellied and golden plovers, Wilson snipe or jacksnipe, yellowlegs (see exception)—Sept. 15–Dec. 16
Exception: Waterfowl and coot in Carbon County—Sept. 7–Dec. 16.
Rail—Sept. 1–Nov. 30

No open season: Elk (except as above), moose, antelope, quail, Mongolian pheasant (1919) dove.

Hunting and fishing licenses: Nonresident: General, $50 (fee $2.50 if applicant pays $10 taxes in State); bear, $10; birds and fish, $5. Each nonresident hunting big game must be accompanied by a guide. Alien: Gun and fish, $25 (not required of holder of $50 hunting license, or resident alien freeholder paying $100 taxes, settler on public lands who has initiated proceedings to acquire title thereto, or of persons engaged in herding sheep). Resident: General, $2.50 (not issued to minor under 15); birds, $1 (not issued to minor under 14); special elk license, $10 (1 additional animal). Guide: Citizen only, $10 (bond, $500). Licenses issued by justice of peace and assistant and deputy wardens.

Unlawful to hunt on inclosed lands of another without consent of owner.

Bag limits and possession: One deer, 2 elk (resident, 1 elk under general license, 1 additional elk under special license), 1 sheep, a season; 18 birds, of which not more than 6 may be sage hens or grouse (2 sage hens in Laramie and Sheridan Counties) a day or in possession.

Sale: The sale of all game of State is prohibited; provided, the sale of game (except edible portion) is permitted when properly tagged. Justice of peace issues tags (fee 25 cents) under affidavit that game was lawfully captured or killed.

Export: The export is prohibited of all protected game; provided, game may be exported if properly tagged, by a justice of the peace, fee 25 cents. Game tags issued under affidavit of lawful killing, and, if edible portion, that is not for sale. Smithsonian Institution or other well-known scientific institutions may export any game animal or birds under permit of State game commission. Exchange of game animals and birds for liberation in Wyoming allowed under permit of the State game commission.

CANADA.

Under the act of August 29, 1917, to give effect to the migratory-bird treaty between the United States and Great Britain the governor general in council is empowered to make regulations, subject to the terms of the treaty, for the protection of migratory birds in Canada. On the promulgation of these regulations the hunting of migratory game birds not protected throughout the year will be restricted to a period not exceeding 3½ months from September 1 to March 10, inclusive, in all the Provinces, except the Maritime Provinces, where the 3½ months open season on shore birds may be between August 15 and February 1. Other provisions of the regulations will conform to the terms of the treaty.

Canada also has a general law prohibiting export of deer (except those raised on private preserves), wild turkeys, quail, partridges, prairie fowl, and woodcock, but permitting each nonresident to export two deer (except in those Provinces further limiting the number) in a year at certain ports within 15 days after the close of the open season, under permit of the collector of customs of the port from which export is made. The ports of export are Halifax and

[1] *Wyoming:* Hunting of big game permitted in Lincoln County on Fall River rim or crest in cattle districts 1, 3, and 5 in Wyoming National Forest, Oct. 5–Nov. 30.

Yarmouth, Nova Scotia; Macadam Junction, New Brunswick; Quebec and Montreal, Quebec; Ottawa, Kingston, Niagara Falls, Fort Erie, Windsor, Sault Ste. Marie, and Port Arthur, Ontario; and such others as the minister of customs may designate.

ALBERTA.

Open seasons: [1]

Deer (male), bull moose, caribou.....Nov. 1–Dec. 14.
Sheep (male), goat.....Sept. 1–Oct. 14.
Hungarian partridge.....Oct. 1–Nov. 30.
Duck, goose, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs.....Sept. 1–Dec. 14.
Rail, coot.....Sept. 1–Dec. 31.

No open season: Elk, wapiti, buffalo, females of deer, moose, sheep, young of all big game, antelope (1925), grouse, partridge, pheasant, prairie chicken, ptarmigan (1918).

Hunting licenses: Nonresident: General, $25; bird, $5. Resident: Big game, $2.50; birds, $2.25 (required only south of Lat. 55°); not required of farmer or member of family residing with him on farm; guide, camp help, $2.50; market hunter, $5. Farmers or their sons residing on own land, big game, $1. Issued by minister of agriculture. Residents north of latitude 55° may also take one head of big game (except elk or buffalo) without big-game license.

Bag limits: Deer, moose, caribou, 1 of each species; 2 sheep, 2 goats; 30 ducks a day, 200 a season.

Sale: Sale of all game birds prohibited.

The flesh of big game may be sold under $10 license. Heads of big game before being sold must be stamped by minister of agriculture at fee of $5 for elk, caribou, moose, sheep; and $2 for deer, antelope, and goat.

Export: Export prohibited of all protected game, except minister of agriculture may grant permits for export of game at the rate of $5 for each head of big game and $1 per dozen for game birds. The holder of a general nonresident license may take with him out of the Province as trophies heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of $1 for each head.

BRITISH COLUMBIA.

Open seasons: [2]

Deer, male caribou (see exceptions), goat.....Sept. 1–Dec. 15.
Exceptions: Deer west of Cascades (except Queen Charlotte Islands, no open season).....Sept. 15–Dec. 15.
Caribou in Rainbow and Hatchie Mountains in Prince Rupert electoral district, and on Queen Charlotte Islands, no open season.
Bull moose (in Atlin, Caribou, Columbia, Fort George, and Omineca electoral districts only).....Sept. 1–Dec. 15.
Male sheep (except in North and South Okanogan, Similkameen, and Yale electoral districts, no open seasons).....Sept. 1–Nov. 15.
Ruffed grouse (see exceptions); blue grouse (west of Cascades only).....Sept. 15–Nov. 14.
Exceptions: Ruffed grouse in electoral districts of Chilliwack, Delta, Dwedney, Richmond, South Vancouver, and district municipality of North Vancouver.....Oct. 15–Nov. 14.
Quail in district municipality of Penticton only.....Oct. 15–Oct. 29.
Pheasants (cocks) in Chilliwack electoral district.....Oct. 15–Nov. 14.
In districts of Dewdney, North and South Vancouver, Richmond, and Similkameen, and on Denman and Hornby Islands in Comox District.....Oct. 15–Oct. 28.
In districts of Cowichan and Delta.....Oct. 15–Oct. 20
Remainder of Province.....No open season.
European partridge, in Delta district only.....Oct. 15–Oct. 20.

[1] *Alberta:* North of latitude 55° any game animal or bird, except elk and buffalo, may be killed at any time if needed for food.

[2] *British Columbia:* No hunting permitted on Kalen Island, Colony farm, and in portion of Burnaby municipality.

Open seasons—Continued.

Duck, goose, rail, coot, plover, snipe, curlew, sandpiper, sand-hill crane (see exceptions)—Sept. 1–Dec. 15.

Exceptions: In Vancouver Island and islands electoral districts—Oct. 15–Feb. 28.

West of Cascades—Sept. 15–Jan. 31.

Brant—Dec. 1–Mar. 10.

No open season: Buffalo, elk, young of deer and goat, and females and young of moose caribou, and sheep.

Hunting and fishing licenses: Nonresident: General, $100; birds, $50; bear, January 1–July 1, $25; angling, $5; British subject, birds, $5 per week. Resident and members of Army, Navy, or Militia on duty in Province; Deer and birds, $2.50; big game and birds, $5. Resident: Big game, birds, and trapping, $10; guide, $5. Issued by warden or any Government agent.

No license to hunt birds and deer required of farmer or member of family on land on which he resides or land contiguous thereto. No license issued to persons under 16 without written consent of parent or guardian. Unlawful to hunt on cultivated or cleared land without owner's consent.

Badge to be worn by licensee. Firearms not to be carried without license.

Bag limits and possession: Three deer of any species, 4 in all; 1 elk, 2 moose (1 in Kootenay County), 3 caribou, 3 goats, 2 sheep of any one species, 3 in all (1 in Kootenay County), 250 duck, 250 geese a season; 6 pheasants, 6 Hungarian partridge, and 12 grouse a day. Flesh of big game may be possessed for six weeks after close of open season.

Sale: Sale prohibited of all game except under regulations of lieutenant governor in council.

Sale permitted of moose and caribou (bulls over 1 year) in electoral districts of Atlin, Caribou, Fort George, and Omineca, October 1–December 15, inclusive. Sale of big game without head attached prohibited. Heads of big game killed without and imported into Province may be sold when branded. Fees, moose and elk, $5; mountain sheep, $4; caribou, $3.

Export: Export prohibited of all protected game except under permit of provincial game warden, provided, heads, horns, and skins of big game lawfully killed by the shipper may be shipped under his hunting license and written permission of minister charged with enforcement of act. Any animal or bird, dead or alive, may be exported for scientific, zoological, or Government purposes under permit of provincial secretary. Live game birds or animals held in captivity under written permission of provincial game warden may be exported.

Miscellaneous: Use of automatic and pump guns prohibited.

MANITOBA.

Open seasons:

Deer, moose, caribou or reindeer, antelope or cabri (males)—Nov. 20–Dec. 10.

Ptarmigan—Oct. 1–Oct. 20.

Duck, goose, brant, coot, gallinule, Wilson snipe, black-bellied and golden plovers, yellowlegs, rail, and woodcock—Sept. 15–Nov. 30.

No open season: Bison or buffalo, elk, females and young of big game, dove; quail, pheasant, Hungarian partridge, introduced game bird (1927), grouse, prairie chicken.

Hunting licenses: Nonresident: Alien, $50. Nonresident British subject, $15. Resident big game, $4; birds, $1. Issued by minister of agriculture. Hunting prohibited on inclosed or cultivated lands, lands covered by buildings or water without consent of owner. No license required of farmers or members of family to hunt on farm on which they reside.

Bag limits and possession: One in all of deer, moose, caribou, and antelope a season; 15 ptarmigan a day, 50 a season; 20 ducks a day in September, 40 a day in October and November; 10 geese a day. Possession of ptarmigan allowed for 10 days and ducks for 3 months after close of hunting season. Venison for private use may be possessed at any time on proof of legal killing.

Sale: Sale prohibited of deer, elk, moose, caribou, antelope (except heads and hides), and all protected game birds.

Export: Export prohibited of all protected game except under permit issued by department of agriculture. No permit shall be issued for export of ptarmigan, prairie chicken, partridge, grouse, geese, ducks, or entire carcass of any moose, elk, caribou or deer; provided, nonresident licensee under permit issued free may export carcass of moose, caribou or deer, and not more than 50 geese and 50 ducks killed by him. (No duck shall be exported before Oct. 1.)

Miscellaneous: Hunters must wear suit and cap of white material. Automatic guns prohibited in hunting waterfowl and ptarmigan.

NEW BRUNSWICK.

Open seasons:

Deer (see exception), moose, and carbou (bulls), partridge.....Sept. 15–Nov. 30.
Exception: Deer on Grand Manan Island, no open season.
Ducks (see exception), goose, brant.....Sept. 1–Dec. 1.
Exception: Black duck.....Sept. 15–Dec. 1
Woodcock, Wilson snipe.....Sept. 15–Dec. 1.
Shore, marsh, or beach birds on beaches, islands, and lagoons bordering tidal waters of Northumberland Strait, Gulf of St. Lawrence, and Bay Chaleur.....Aug. 15–Dec. 31.

No open season: Calf under 3 years and cow of moose and caribou; pheasant.

Hunting licenses: Nonresident: General, $50; bird, $10; Westmoreland County, $25; fish, $5. Resident: Big game, $2; sinkbox for waterfowl, $1; guide, $2; camp help, $1. No license issued to person under 18. Issued by Crown Land Department. Nonresident licensee must have registered guide.

Bag limits and possession: Two deer, 1 moose, 1 caribou (lumber camp limited to 2 moose and 2 caribou) a season; 20 ducks, 10 partridges, 10 woodcock a day. Game may be kept for personal use in cold storage during close season under permit.

Sale: Sale of partridge and woodcock prohibited until September 15, 1919; of other game during close season, except goose and brant may be sold between September 1 and March 1 and other game and parts thereof under permit applied for within 10 days after close of season may be sold within 10 days after granting permit. Keepers of hotels, inns, etc., may serve game during open season and 15 days thereafter. Dealer under $1 license from surveyor general may sell three deer at retail and heads and hides to taxidermists; and hides and skins of animals may be sold under license by nonresidents or aliens, fee, $25; and residents, fee, $2.

Export:[1] Export of all game prohibited, except that surveyor general may issue license to export games alive or dead.

Miscellaneous: Automatic guns prohibited in hunting big game and waterfowl.

NEWFOUNDLAND.

(1917 laws not received.)

Open seasons:[2]

Caribou (except in a special region near Grand Lake, no open season).....Aug. 1–Sept. 30. Oct. 21–Jan. 31.
Hare, rabbits.....Sept. 20–Jan. 1.
Ptarmigan, willow grouse or partridge, plovers, curlew, snipe, or "other wild or migratory birds (except wild geese)".....Sept. 20–Jan. 1.

No open season: Elk, moose.

Hunting licenses: Nonresident, $51; resident, $5; guide, nonresident, $50, resident, free.

Caribou licenses issued by minister of marine and fisheries, stipendary magistrate, or justice of peace.

Unlicensed guides not to be employed. Guide shall not guide party of more than three sportsmen.

Bag limits: Three caribou (stags) a season by nonresident licensee; 2 stags, 1 doe by resident.

Sale: Caribou may be sold from August 1 to January 1; ptarmigan, willow grouse taken in open season may be sold until January 15; other birds may be sold during open season.

Export: Export for sale prohibited of caribou, partridge, willow or other grouse; provided, minister of marine and fisheries may issue licenses to export caribou for breeding or scientific purposes. Licensee may export three stag caribou under hunting license and export permit (fee, 50 cents); resident may export antlers, head, or skin of caribou under export permit, but not, in either case, for sale.

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[1] *New Brunswick:* Except in the case of partridge, the prohibition applies only to common carriers.

[2] *Newfoundland:* Poor settlers may kill any birds except capercailzie and black game at any time for immediate consumption by themselves or their families.

NORTHWEST TERRITORIES.

Open seasons: [1]

Deer, elk or wapiti, moose, caribou, goat, sheep	July 15–Oct. 1. Dec. 1–Apr. 1.
Musk ox	Oct. 15–Mar. 20.
Partridge, prairie chicken, grouse, pheasant	Sept. 1–Jan. 1.
Duck, goose	Sept. 1–Jan. 15

NOVA SCOTIA.

Open seasons:

Deer, male (except on Cape Breton Island, no open season)	Oct. 21–Oct. 31.
Moose, bulls (except on Cape Breton Island, no open season)	Sept. 16–Nov. 30.
Caribou, bulls, in Inverness and Victoria Counties only	Sept. 16–Oct. 15.
Hare, rabbit	Oct. 1–Apr. 30.
Partridge or ruffed grouse	Oct. 1–Oct. 31.
Woodcock, Wilson snipe	Sept. 1–Dec. 31.
Ducks (black, Harlequin, golden-eye, and scaup)	Sept. 15–Feb. 28.
Quail, ptarmigan, sharp-tailed grouse, plover, shore birds, rail, coot, goose, brant, and teal and ducks (except as above)	Aug. 15–Nov. 30.

No open season: Females and young of deer, moose, and caribou (1918); Canada grouse (spruce partridge), pheasant.

Hunting licenses: Nonresident: All game, $30; birds and small game, except woodcock and snipe, $15; nonresident paying taxes equal to license fee, $5; alien who has not resided in Province five years, $5; resident to hunt caribou outside county of residence, $5. Guide, resident, $2. Issued by provincial secretary, game commissioners, and county clerks.

Bag limits: One moose a season; 5 ruffed grouse, 10 woodcock a day.

Sale: Sale prohibited of deer, caribou, pheasant, blackcock, capercailzie, Canada grouse (spruce partridge), chukar partridge.

Moose (meat only) may be sold from September 16 to November 1 under certificate showing lawful killing; rabbit, December 1 to April 30; any game bird other than those above mentioned during the open season with the exception of the first three days.

Export: Export prohibited of all protected game, except holder of nonresident general license may ship out of Province under license tag 1 moose lawfully shot by himself. Mounted heads and dressed skins and live mammals or birds for propagating or scientific purposes may be exported under permit from provincial secretary.

Miscellaneous: Unlawful to use rifle or gun loaded with bullet to shoot wild fowl.

ONTARIO.

(1917 regulations not received.)

Open seasons: [2]

Deer	Nov. 1–Nov. 15.[3]
Moose, caribou (bulls only) (cows and calves under 1 year of age, no open season)	Oct. 10–Nov. 30.[4]
Hare [5]	Oct. 15–Nov. 15. Dec. 23–Jan. 1.
Squirrel (black or gray) (see exceptions)	Nov. 1–Nov. 15.
Exceptions: Waterloo and York (1918); Elgin, Oxford, and Wentworth (1919).	
Wild turkey	Nov. 1–Nov. 15.
Woodcock	Oct. 15–Nov. 15.
Goose	Sept. 15–Apr. 30.
Black-bellied and golden plovers, Wilson snipe, rail, duck, and other waterfowl	Sept. 1–Dec. 31.

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[1] *Northwest Territories:* Indians, inhabitants, travelers, explorers, and surveyors in need of food exempt. Governor general in council, by regulation, may alter seasons.

[2] *Ontario:* Lieutenant governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River, and in the vicinity of Rondeau Park, and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

[3] Persons who put deer on their own lands and their licensees may hunt such deer, Oct. 1–Nov. 15.

[4] South of the Canadian Pacific R. R. from Mattawa to Port Arthur, Nov. 1–15.

[5] Hares may be killed during close season by any means other than shooting.

No open season: Fawns, elk, or wapiti, dove, partridge, grouse, prairie fowl (1918); capercailzie (1920); quail, Hungarian partridge, pheasants (1919).

Hunting licenses: Nonresident: General, $25. Resident: Moose and caribou, $5; deer, $2. Guide, $2. Issued by superintendent of game.

Bag limits and possession: One deer, 1 moose, 1 caribou a season; 200 ducks a season. Two or more persons hunting together under license may kill an average of 1 deer each.

Sale: The sale of waterfowl, woodcock, and snipe, prohibited to September 14, 1917. All other native game may be sold during the open season by the person killing it, and by dealers during open seasons and until the following January 1, under license. Hotels, restaurant, and clubs under license may sell during closed season. Imported game may be sold under special regulations and licenses. Game breeders may sell animals for breeding purposes under permit.

Export: The export of all wild game animals and birds is prohibited; provided, 1 deer, 1 bull moose, 1 bull caribou, and 100 ducks may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Lawfully imported game and deer, moose, elk, or caribou in private ownership may be exported. Minister may issue permit for the export of game, dead or alive, at any time.

PRINCE EDWARD ISLAND.

Open seasons:

Hare, rabbit	Nov. 1–Feb. 1.
Partridge (in alternate years, 1917, 1919, etc.)	Oct. 15–Nov. 15.
Black-bellied and golden plovers	Aug. 1–Jan. 1.
Duck, Wilson snipe, woodcock	Sept. 1–Jan. 1
Goose	Sept. 15–May 10.
Brant	Apr. 20–Jan. 1.
Yellowlegs, shore, and other birds along beaches, shores, and marshes bordering tidal waters	Aug. 20–Jan. 1.

Hunting licenses: Nonresident, $15. If applicant pays taxes on real estate valued at $325, fee $5; sons and brothers of residents returning for visit, $2.50; guest, $2. Issued by game inspectors and tax collectors. Hunting on inclosed lands without permission of owner prohibited.

Bag limits and possession: No limits.

Sale: Game lawfully killed may be sold.

Export: Export prohibited of all game except geese and brant; provided, nonresident licensee may carry out of Province 12 birds killed by himself if tagged and carried open to view.

Miscellaneous: Use prohibited of automatic, pump, machine gun, rifle, or other gun loaded with bullets in hunting game birds.

QUEBEC.

Open seasons:

Deer, bull moose (see exception)	Sept. 1–Dec. 31.
Exception: In Labelle, Ottawa, Pontiac, and Temiscaming Counties	Oct. 1–Nov. 30.
Caribou	Sept. 1–Jan. 31.
Hare	Oct. 15–Jan. 31.
Bear	Aug. 20–June 30.
Birch or swamp partridge	Sept. 1–Dec. 14.
White partridge or ptarmigan	Nov. 1–Jan. 31.
Widgeon, teal, duck (except shelldrake)	Sept. 1–Feb. 28.[1]
Woodcock, plover, snipe	Sept. 1–Jan. 31.

No open season: Cow moose, young of deer, moose, and caribou, eider duck, pheasant (1920.)

Hunting licenses: Nonresident: General, $25 (members of incorporated hunting clubs, $10). Resident, $1 (not required of resident British subject hunting for own use); resident special, $5 (3 deer and 3 caribou additional to limit). Issued by Minister of Colonization.

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[1] *Quebec:* Inhabitants in territory north and east of Saguenay River and of Gaspe County may take these birds for food, Aug. 1–June 1.

Bag limits and possession: Two deer, 1 moose, 2 caribou in season; 3 caribou and 3 deer under special resident license. Game lawfully killed may be possessed until 15 days after close of open season.

Sale: Sale of birch or spruce partridge prohibited until October 1, 1920. Game lawfully taken may be sold from the third day of open season to and including the fifteenth day after expiration of open season. Licensed hotels, restaurants, and clubs may serve game lawfully taken, except birch or spruce partridge.

Export: Export of moose, caribou, and deer, or parts thereof, prohibited except under permit issued from Minister of Colonization (fee not to exceed $5); also under tags attached to nonresident license not later than 15 days after close of season.

SASKATCHEWAN.

Open seasons: [1]

Deer, elk or wapiti, moose, caribou (males only)----------Nov. 15–Dec. 14.[2]
Duck, goose, coot, Wilson snipe or jacksnipe, black-bellied and golden plovers, yellowlegs, rail----------Sept. 15–Dec. 31.

No open season: Antelope, buffalo, and female of big game and young of big game under 1 year of age.[3] English pheasant, whooping crane, partridge (ruffed grouse), sage grouse, Canada or spruce grouse, prairie chicken (1918).

Hunting licenses: Nonresident: Big game, $25; birds, $10; six-day bird license, $2.50. issued by minister of agriculture. Resident, big game, $5; birds, $1.25 (required of resident of city or town). Issued by minister or agent. No license issued to person under 16 without written consent of parent or guardian. Hunters must wear white suit and cap. Hunting prohibited on inclosed lands without consent.

Bag limits and possession: One elk; 2 in all of deer, moose, and caribou a season; 10 ptarmigan a day, or 100 a season; 50 waterfowl a day, 250 a week.

Sale: Sale of all protected game prohibited.

Export: Export of all protected game prohibited; provided, minister of agriculture may grant permits to export for scientific purposes or propagation in public parks and zoological gardens 1 pair of each species of big game and game birds upon payment of $5, or for propagation a specified number on application of another Province or State. Minister may issue permits to export deer (fee $2 per head) or other big game (fee $5 per head), birds (except grouse family) (fee $1 per dozen, limit 5 dozen per season). Nonresident licensee on leaving Province may take with him personally under his license and permit big game and 100 game birds legally killed.

YUKON.

(1917 laws not received.)

Open seasons: [4]

Deer, elk or wapiti, moose, caribou, sheep, goat, musk ox (males only)----------Sept. 1–Mar. 1.
Partridge, prairie chicken, grouse, ptarmigan, pheasant----------Sept. 1–Mar. 15.
Wilson snipe, duck, goose----------Aug. 10–June 1.

No open season: Bison or buffalo and females of other big game.

Hunting licenses: Nonresident, $100. Issued by commissioner or game guardian.

Bag limits: Six caribou or deer, 2 moose, 2 elk, 2 sheep, 2 goats, 2 musk oxen a season.

Sale: Deer, elk, moose, caribou, bison, musk oxen, sheep, and goats may be sold during the open season and 60 days thereafter.

Export: Protected game may be exported by a nonresident only under a hunting license and a shipping permit issued by the commissioner of the territory or a game guardian. Heads of game may be exported, if declared before a game guardian.

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[1] *Saskatchewan:* Lieutenant governor in council may extend close seasons over current year, within limits, on petition of six game guardians.

[2] Applies north of line between townships 34 and 35; south of said line no open season.

[3] Male moose and elk having horns less than 6 inches in length deemed to be under 1 year of age.

[4] *Yukon:* Indians, explorers, surveyors, prospectors, miners, and travelers in need of food may take game during close season. Commissioner in council may alter seasons.

DISPOSITION OF GAME RAISED IN CAPTIVITY.

The marked success achieved by many persons in the propagation of certain game animals and wildfowl on farms and preserves is attracting widespread attention to this industry in the United States and Canada. The general prohibitions against the sale of game in force in most States have created a great demand for domesticated game to supply the market. It is unquestioned that deer, elk, and many species of waterfowl can be profitably raised in captivity on land unsuited for agriculture or in connection with agricultural pursuits. The need of the hour is the enactment of such uniform, comprehensive laws as will not only foster the industry and permit domesticated game to reach the market for consumption at all seasons, but will prevent infringement of laws conserving the supply of native game. Much is to be desired in the way of coordinating Federal and State laws relative to the propagation of wild waterfowl.

About two-thirds of the States now have some special provision regulating possession, sale, or export of game raised in captivity. The following table giving a digest of the various State laws on the subject serves to show the lack of uniformity and the need of additional legislation to attain the results desired:

Arkansas: The commission may establish rules governing propagation of game in captivity and authorize the sale or export of such game under permit.

California: Game raised in captivity under breeder's license (fee, $2.50) may be sold at any time for breeding purposes or may be sold under license and regulations of commissioners for food when properly tagged (fee, 3 cents a tag). All domesticated game (except deer) must be killed otherwise than by shooting.

Colorado: Game furnished from a private park or lake of class A may be sold by hotels and restaurants at any time. Game taken from licensed private parks may be sold or shipped at any time if accompanied by an invoice.

Connecticut: Deer, pheasants, and wild fowl raised in licensed preserves (fee, $2) may be sold or transported at any time, when duly tagged under regulations of commissioners of fisheries and game.

Delaware: Unlawful to kill, sell, or possess Hungarian partridge or pheasant except for scientific or propagating purposes.

Georgia: Registered breeder may sell game for propagation.

Illinois: Deer raised in inclosure for market may be killed and sold October 1–February 1; cock pheasants, November 1–February 1, under permit. Game animals and birds raised in captivity under license (fee, $2) may be sold for propagating or scientific purposes at any time.

Indiana: Game raised in captivity may be killed, sold, or transported at any time.

Iowa: Game raised in capticity under license (fee, $2) may be sold.

Kansas: Game raised in captivity may be transported under permit of warden and $1,000 bond for scientific or propagating purposes.

Kentucky: Game birds and game animals bred in captivity under permit may be sold, transported, or otherwise disposed of at any time when duly tagged.

Louisiana: Game raised in captivity under $5 license may be sold alive for stocking or breeding purposes, and may be killed, transported, and sold for food at any time, if tagged with metal tag. Traffic in birds killed by shooting prohibited.

Maine: Game raised in captivity under a $2 breeder's license may be killed, sold, or transported at any time under regulations of commissioners.

Maryland: Elk and imported and native deer raised in licensed preserve (fee, $5) may be sold, dead or alive, at any time (in Allegany and Garrett Counties white-tailed deer native to the State must be branded three months prior to killing). The propagation and killing of English or ring-necked pheasants in captivity is permitted. In Washington County game animals and birds reared in licensed preserves (fee, $10) may be sold for propagation only.

Massachusetts: Quail reared in captivity under permit may be exported. Game may be reared in captivity under license (no fee) and sold for propagation under regulations of commissioners; deer, elk, pheasants, quail, European or gray partridge, and wild fowl may be reared in captivity under license (no fee) and sold for food, when properly tagged. Tag fee, 5 cents. Licensed dealers may sell such game.

Michigan: Deer, elk, pheasants, and wild ducks may be raised in captivity under $5 license and sold at any time for breeding or stocking purposes and the carcasses transported or sold for food when properly tagged (fee, 5 cents). Ducks killed by shooting (except under direct supervision of a deputy warden) may not be sold or disposed of. Licensed retail dealer, club, hotel, restaurant, etc., may sell portion of tagged game to patron or customer for actual consumption or use without additional license.

Minnesota: Game raised in captivity under license (fee, 50 cents for each big-game animal) may be sold at any time—game animals under a permit and birds under a tag. Domesticated big game may be exported under permit.

Missouri: Deer and elk raised in captivity under license (fee, $5) may be transported and sold under regulations of the commissioner.

Nevada: Game raised in licensed preserve (fee, $10) may be sold or shipped at any time under invoice.

New Hampshire: Game raised in captivity under $2 license may be sold or transported at any time when properly tagged, under regulations of commissioner.

New Jersey: Deer raised in licensed preserve may be killed at any time. Deer, introduced pheasants, and mallard, black, and wood ducks raised in inclosed licensed preserve, if properly tagged, may be sold for food or exported for sale, if shipped open to view. Tag fee, 5 cents. Live deer, on payment of $5 for each animal, and game birds may be exported for propagation. Breeder's license fee, $5.

New Mexico: Game raised in licensed preserve may be exported or sold at any time.

New York: Elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, mallard, and black ducks raised in captivity under license may be sold for breeding purposes and may be killed, sold, or exported at any time under license when properly tagged. Said ducks may be killed by shooting only during open season, but ducks killed by shooting may not be sold, except under regulations of commission. Varying hares and cottontail rabbits bred in captivity under $5 license may be sold for food during close season, when properly tagged, under rules and regulations of the conservation department.

North Carolina: Twenty-two counties have laws in regard to certain game raised in captivity.

North Dakota: Board may issue permits to breed or domesticate game.

Ohio: English ring-neck, Mongolian, or Chinese pheasants may be bred in captivity under 50-cent permit, and when killed may be sold or shipped if tagged with a distinctive metal tag. Packages for shipment must be labeled to show contents. Game birds and squirrels may be kept in inclosures for domestication.

Oklahoma: Game raised under license (fee, $2) may be transported for propagation at any time, and for food, when properly tagged, during season prescribed by commissioner.

Oregon: Game birds and animals raised in captivity under permit (fee, $2) may be exported or sold at any time upon being properly tagged by commissioner or deputy. Tag fee, 5 cents each. Packages containing game to be plainly labeled.

Pennsylvania: Game breeder's certificate, fee $1, bond $500. Game raised in captivity may be sold alive or dead within the State.

Rhode Island: Game raised in captivity under permit may be sold at any time for propagation, under regulations of commissioners.

South Carolina: Any birds or animals protected by law may be kept in possession for purposes of propagation or domestication.

South Dakota: Game raised in captivity may be exported or sold under written permission of State game warden.

Vermont: Game raised in licensed private preserves (fee, $2) may be exported at any time when duly marked and tagged, and may be sold for propagation at any time, or for food, under tag in accordance with regulations of commissioner.

Washington: Game raised in captivity may be exported under permit from State warden or county game commission and may be killed and sold at any time.

West Virginia: The owner of elk kept in inclosure may kill them at any time, and may pursue and recapture, by killing or otherwise, elk which have escaped from his inclosure. Tame deer may be killed by the owner.

Wisconsin: Under permit and supervision of the commission wild animals may be taken and transported for propagation within the State.

Wyoming: Natural increase of big game (except moose) captured under permit (fee, $1) and held for propagation may be exported or sold.

NEW LAWS PASSED IN 1917.

[For correct seasons for hunting migratory birds and other game see "Summary of laws relating to seasons, licenses, etc.," pp. 10–46.]

Federal laws.—Three acts: Establishing the Mount McKinley National Park in Alaska (64th Cong., Public No. 353); provisions in the Agricultural appropriation act increasing the appropriations for the enforcement of the Lacey Act from $14,600 to $22,000 and for maintenance of reservations from $25,000 to $35,000 (64th Cong., Public No. 300, p. 24); and in the sundry civil act increasing the amount appropriated for feeding buffalo in Yellowstone National Park from $3,000 to $5,000 (65th Cong., Public No. 21, p. 53).

Alabama.—No session of the legislature.

Alaska.—By regulation: Prohibiting the killing of deer on Hinchinbrook and Montague Islands, in Prince William Sound, before August 1, 1919; and prohibiting the killing of female mountain sheep or lambs. (S. R. A.—B. S. 15.)

Arizona.—Three acts: Initiative petition adopted at the general election November 7, 1916, fixing the open seasons and reducing bag limits as follows: Deer from 2 to 1, turkeys from 3 to 2 a season; quail, waterfowl, and larger shore birds from 25 to 20, and doves and whitewings from 35 to 25 a day; providing license fees of $1.25 for resident fishing or hunting, $20 for aliens or nonresidents for fishing or hunting any kind of game, and $10 for aliens or nonresidents hunting any game except deer and turkeys; establishing the Mount Graham and the Pinal Mountain Preserves on the Crook National Forest; the Huachuca Preserve on the Coronado National Forest; and the Blue Range Preserve on the Apache National Forest. (S. B.'s 8 and 52.)

Arkansas.—One act: Revising the entire game law, protecting does, turkey hens, prairie chickens, grouse, and woodcock to 1922, making the seasons for migratory birds conform with the Federal regulations, and permitting nonresidents to hunt under a $15 license. (S. 109.)

California.—Twenty-two acts: Amending the term "predatory animals" to include the black-tailed jack rabbit (ch. 50); establishing the Mount Tamalpais Game Refuge, in Marin County (ch. 664); requiring anyone killing a deer to retain the skin and part of the head bearing the horns, during the open season and 10 days thereafter, and to produce it upon demand of any game official (ch. 54); amending section 626j of the Penal Code so as to permit a hunter to run deer during the open season with one dog (ch. 56); appropriating $10,907 to reimburse the fish and game preservation fund for money paid employees as compensation benefits for accidents incurred in service (ch. 314); amending the section prohibiting shooting ducks from a motor boat while in motion so as to prohibit the use of motor boats in shooting in district 4a on Bear Lake (ch. 688); providing for the issue of free hunting licenses to Civil War veterans (ch. 514); amending the provision in regard to permits for capture of game for scientific or propagating purposes (ch. 95); amending the law relative to transportation of game (ch. 67); prohibiting receipt from or transportation for any person of more than the legal bag limit of game and prohibiting the shipment of any fish or game by parcel post (ch. 515); amending the law on doves so as to open the season in district 1 from July 1 to October 31, both dates inclusive (ch. 41); changing the seasons so as to make the open seasons on migratory birds conform with those under the Federal regulations, protecting all shore birds except jacksnipe throughout the year, shortening the grouse season to one month from September 15 to October 14, inclusive, protecting sage hens in Mono and Inyo Counties throughout the year, and shifting the season on quail one month later, November 15 to January 31 (ch. 516); amending the Bowman Act relative to the propagation of game and reducing the license fee from $25 to $2.50 (ch. 774); strengthening the

elk law by making possession of elk meat prima facie evidence of violation of the act (ch. 42); permitting the shipment under a proper affidavit of a whole deer lawfully killed in any district during the open season to another district in which the season is closed (ch. 519); amending the nongame bird section so as to remove protection from black birds in game districts 1, 2, and 3; providing that anyone holding a hunting, angling, market fisherman, or wholesale dealer's license when convicted a third time for violating the game law shall surrender his license and shall be denied a new license during the remainder of the year (ch. 780); an act dividing the State in 26 fish and game districts, establishing 16 new game refuges, and repealing previous districting acts—game districts are numbered 1, 2, 3, and 4 (hunting is also permitted in fishing districts 23, 24, 25, and 26), and game refuges are marked with the number of the game district in which located and a distinctive letter, thus simplifying the system of nomenclature (ch. 643); prohibiting all sale of aigrettes, birds of paradise, goura, or numidi after November 1, 1917 (ch. 523); amending the law regulating the issue of licenses by requiring a bond when demanded by the board of fish and game commissioners (ch. 524); amending the provision for appointment of county game wardens (ch. 47); removing protection from blackbirds in districts 1, 2, and 3 (ch. 520); authorizing capture of fish or game for scientific or propagating purposes, on refuges, by game commission (ch. 641).

Colorado.—Two acts: Amending the sections relative to licenses, limits, and seasons, providing a four-day open season on deer beginning in 1918, and eliminating spring shooting by making the seasons on waterfowl and shore birds conform with those under the Federal regulations (ch. —); authorizing landowners and tenants to capture or kill pheasants destroying crops, provided a permit is first obtained from the game commissioner (ch. —).

Connecticut.—Eight acts: Making it an offense to make a material false statement in obtaining a license (ch. 82); amending the act concerning hunting licenses (ch. 124); making the close season for gray squirrels November 24 to October 7, both inclusive, and limiting possession to 6 squirrels a day or 30 in a season (ch. 187); authorizing the publication biennially of 50,000 copies of the fish and game laws (ch. 216); making the close season for black-bellied and golden plover, yellowlegs, and jacksnipe, December 1 to August 31, both inclusive, and the bag limit 10 a day of any or all these species (ch. 228); amending the law concerning the appointment of commissioners of fisheries and game and fixing the salary of the superintendent of fisheries and game at $3,000 per annum (ch. 252); changing the close season for hares and rabbits to February 1 to October 7, both inclusive (ch. 312); amending the close season for quail, woodcock, partridges, and pheasants to November 24 to October 7, both inclusive (ch. 412).

Delaware.—One act: Repealing the special law restricting wild-fowl hunting to Tuesdays, Wednesdays, and Fridays on Assawaman Bay and tributaries (ch. 212).

Florida.—Two acts: Shortening the season 10 days on deer and on game birds by closing it on March 1, instead of March 10, and reestablishing the county warden system (ch. 7311); fixing nonresident license fee at $25 for Taylor County (ch. 7607).

Georgia.—No legislation.

Idaho.—Four acts: Amending the game law generally; closing the season on Hungarian partridges and ring-necked pheasants, except in four counties, and on quail until 1920; shortening the season on grouse one month from August 15 to December 1, to August 16 to October 31; shortening the season on turtle doves two and a half months from July 15 to December 1, to August 1 to September 30; changing the seasons on migratory game birds to conform with

the Federal regulations; shortening the deer season two weeks by opening September 16 instead of September 1, and in certain counties changing the season from September 20 to December 20, to October 16 to December 31; reducing bag limits generally (ch. —); establishing the Big Lost River Game Preserve, on the Sawtooth National Forest (S. B. 100), the Big Creek Game Preserve, on the Salmon National Forest (H. B. 131), and the Selway Game Preserve, on the Selway National Forest (H. B. 319).

Illinois.—One act: Consolidating various State offices, abolishing the game and fish commission, and placing the work in charge of a chief game and fish warden under the director of agriculture (p. —). A comprehensive bill amending the game law was passed by the legislature but vetoed by the governor.

Indiana.—Postponing opening of squirrel season one month, to August 1 (ch. 53).

Iowa.—Four acts: Closing season on quail and prairie chickens until November 1, 1922; authorizing the State fish and game warden, with the consent of the executive council, to establish public parks in any county on shores of waters of historic or scientific interest; appropriating annually $50,000 from the fish and game protection fund for the improvement of such parks, provided this amount does not exceed one-half the total receipts of the fund (chs. 111, 202, 233, and 236).

Kansas.—One act: Accepting grant of lands from the Federal Government for a game preserve (ch. 202).

Kentucky.—No session of the legislature.

Louisiana.—No session of the legislature.

Maine.—Two acts: Revising the inland fish and game laws, eliminating many special laws, making the seasons on migratory birds uniform with the Federal regulations, and empowering the commissioner to fix local seasons by regulation (ch. 219); abolishing the commission and creating the office of commissioner of inland fisheries and game (ch. 244).

Maryland.—One act: Removing protection from squirrels in St. Mary County (ch. 37, extra session).

Massachusetts.—Twelve acts: Removing protection from the starling (ch. 20); amending the law relative to the issue of hunter's licenses (ch. 26); prohibiting the bringing of cats to the Island of Muskegat or possession of live cats on the island (ch. 40); making the close season on waterfowl in certain counties January 16 to September 30 (this act by its terms does not authorize hunting in violation of Federal regulations) (ch. 73); establishing Arbor and Bird Day on the last Saturday in April (ch. 74); fixing salary of State ornithologist at $2,000 and providing $1,500 for traveling and other expenses (ch. 75); changing the open season for deer from the third week in November to the first week in December (ch. 139); closing the season on quail for five years in Hampden and Middlesex Counties (ch. 157); changing the season on upland game from October to November, except in Berkshire, Franklin, Hampden, and Hampshire Counties, and providing that in these counties the open season on woodcock shall be October 20 to November 30 (ch. 170); permitting the capture of European hares at any time in Berkshire County (ch. 196); prohibiting the capture of hares in Norfolk and Bristol Counties until 1920 (ch. 225); authorizing the commissioners of fisheries and game to enforce the laws relating to dogs (ch. 271).

Michigan.—Seven acts: Authorizing the game commissioner, on petition of the supervisors of any county to regulate the open season for any game except waterfowl (S. A. 3); authorizing the expenditure of license receipts for propagation of game and other purposes (H. A. 126); placing receipts from licenses and fees in game fund to be available for expenses of department

(H. A. 137); amending law in regard to posting lands; making it unlawful while hunting to skin or otherwise destroy the identity of any bird; reenacting the provision relative to illegal methods of hunting deer; declaring cats public nuisances when found at large and declaring it a misdemeanor for owner to permit cats to run at large after notice from commissioner; prescribing bag limits for geese and brant, 6 a day, 15 in possession, 25 a season; making seasons on migratory game birds uniform with Federal seasons (H. A. 181); amending the game-law administration act (H. A. 207); authorizing State game and fish warden to appoint warden of Wayne County, at $2,500 for salary and expenses (H. A. 209); allowing hunting parties of not less than six to kill under permit one deer for camp purposes (H. A. 227).

Minnesota.—Nine acts: Shortening open season on game birds and reducing bag limits (ch. 121); prohibiting the killing of game from motor vehicles (ch. 225); permitting resident licensees to ship hides and heads of big game for tanning or mounting (ch. 226); authorizing rewards for information concerning violations of game and fish laws (ch. 249); amending definition of game birds and authorizing commissioner to issue permits to kill birds injuring game birds on State refuges and game farms, and fish at State hatcheries (ch. 253); authorizing exchange of game with Federal Government for restocking purposes and the granting of scientific collecting permits to colleges and universities, and to municipalities maintaining zoological collections (ch. 281); permitting nonresident to export one deer or one moose under license coupons (ch. 310); providing for commission of five members to prepare a codification bill of game and fish laws, for the legislature of 1919 (ch. 461); prohibiting aliens from hunting, or owning or possessing shot gun, rifle, or other firearm (ch. 500).

Mississippi.—No session of the legislature.

Missouri.—One act, diverting 5 per cent of license receipts for purchase of a park.

Montana.—Four acts: Establishing a game preserve in the South Moccasin Mountains, Fergus County (ch. 109); ceding jurisdiction to the United States over that part of Yellowstone National Park in Montana (ch. 112); authorizing payment from the State game and fish fund of costs of prosecuting violations of game and fish laws (ch. 138); general codification of the game law including 88 sections (ch. 173).

Nebraska.—General act: Increasing salaries of chief deputy and three deputy game wardens; making the open season on waterfowl and shore birds uniform with the Federal regulations; removing quail, doves, and plover from the game list, and shortening the season one month on prairie chicken, sage hen, and grouse by opening September 15 and closing November 15; permitting boys under 18, if accompanied by parent or guardian, to hunt without licenses (ch. 55).

Nevada.—Three acts: Protecting elk and making killing of elk or possession of hides or meat a felony (ch. 217); general game law protecting sheep, goats, elk, and antelope until 1930 (ch. 239); authorizing the appointment of a board of fish and game commissioners of three members for a term of four years and a State warden at a salary of $1,800 per annum (ch. 240).

New Hampshire.—Two acts: Providing for payment from the fish and game fund upon assessment by the commissioner of agriculture of damages for injury to live stock caused by persons hunting deer (ch. 153); amending the game law generally, changing the seasons for deer, the manner of hunting deer, and provisions regarding rabbits; modifying the penalty for jacking wild ducks; reenacting the sections relative to licenses; authorizing the issue of permits for propagation of game under regulations of the fish and game commission on payment of a fee of $2; authorizing the commission, with consent of land

owners, to establish State game sanctuaries not exceeding 1,000 acres in any one tract, and closing the season on such reservations for a period of not more than 10 years; prohibiting shooting from automobiles or other motor vehicles; exempting colleges from the provisions of the fish and game laws when securing museum specimens, subject to the approval of the game commission; amending the provisions regulating compensation for damage done by deer and making the seasons for migratory birds conform with those under the Federal regulations (ch. 184).

New Jersey.—Three acts: Amending the law relative to hunting waterfowl so as to prohibit hunting from a motor boat or from any boat or structure more than 100 feet from shore, marsh, or ice (ch. 38); providing a $5 license for raising or selling English pheasants, black ducks, mallard ducks, wood ducks, and deer (ch. 85); enlarging the board of game and fish commissioners from four to seven members to serve five years (ch. 96).

New Mexico.—No legislation.

New York.—Seven acts: Amending the law in regard to breeding ducks in captivity (ch. 193); opening the season for deer in Columbia, Dutchess, and Rensselaer Counties by permitting landowner or lessee to kill one deer with a shotgun during the regular season (ch. 327); amending the following sections of the conservation law in relation to game—section 168, increasing the salary of the chief game protector from $4,000 to $5,000, and of the deputy chief game protector from $2,400 to $3,000; section 182, amending the language relative to penalties; section 185, subdivisions 2 and 6, authorizing town and city clerks to administer oaths to applicants for licenses, omitting the size of the license button, and providing that no penalty other than forfeiture of license shall be suffered by licensee for failing to have his hunting license on his person; section 211, closing the season on waterfowl on December 31 instead of January 10, and extending the season for possession from January 15 to January 20; section 212, extending the open season on waterfowl on Long Island five days, January 10 to 15, and permitting the taking of waterfowl at any distance from the shores of Lake Erie, Niagara River, and Oneida Lake; section 214–3, allowing the hunting of pheasants on the first two Saturdays instead of the first two Thursdays in November; section 215, reducing the bag limits for game on Long Island to 6 quail, 4 pheasants, 2 grouse per day, and 40 quail, 30 pheasants, and 15 grouse per season; section 219, protecting the crow blackbird and removing protection from the great gray owl; section 220, removing protection from the nests of the great gray owl, great blue heron, and bittern; section 372, amending the law in regard to breeding ducks in captivity (ch. 486); authorizing owners to take licensed dogs afield for training during the month of September under permit from the commission (ch. 491); amending section 361 relative to notices by providing that in parks of 700 acres or more notices need be posted only once in three years if defaced signs are replaced annually during the month of September (ch. 492); amending section 366 relative to State game refuges by providing for inclosing water as well as land, and defining the number and size of notices to be posted on such refuges (ch. 499); appropriating $15,000 for the establishment of a game farm in Tompkins County, to be administered by the trustees of the New York State College of Agriculture, but the surplus product of the farm to be placed at the disposal of the conservation commission (A. 917). Orders of the commission under section 152, providing additional protection for pheasants in Chemung, Genessee, and Delaware Counties until 1918.

North Carolina.—Three general and 58 local laws.

North Dakota.—Two acts: Authorizing private individuals to establish inclosed game preserves of not less than 2 acres for propagation of deer, elk, and antelope (p. 95); amending the game law in regard to seasons and limits and

conforming seasons for migratory game birds to the Federal regulations (p. 167).

Ohio.—Three acts: Adding the bob-white quail to the list of protected non-game birds (p. 17), fixing a bag limit on rabbits (p. 143), and requiring written permission to hunt on land of another (p. 493).

Oklahoma.—Three acts: Exempting from taxation deer, buffalo, elk, and antelope kept for propagation or exhibition (S. B. 137); appropriating $94,197.10 from the State treasury for the purchase of State game preserves, this sum being the amount transferred as a loan from the game-protection fund to the State capitol building fund in 1913 (H. B. 374); amending the game law of 1913 by providing that the State game and fish warden shall furnish the assistant wardens with resident hunting licenses in books of 25 each; closing the season on deer for five years; protecting antelope, wild turkeys, prairie chickens, long-billed curlews, wood ducks, cranes, pelicans, gulls, and herons at all seasons; making the open seasons for migratory birds conform with those under the Federal regulations; fixing bag limits; providing that payments not exceeding $200 in any county for bounties on hawks, crows, or other enemies of game or birds will be refunded to the county treasurer by the State game and fish warden; prohibiting importation, sale, or possession of aigrettes or plumage of wild birds; authorizing sheriffs, constables, marshals, and policemen to enforce the game and fish laws and to receive 50 per cent of the fines in addition to their usual fees; fixing a penalty of $25, or imprisonment for not more than 30 days, or both, for violation of any provision of the game and fish laws for which no specific penalty is otherwise provided (H. B. 542).

Oregon.—Six acts: Authorizing the issue of free hunting licenses to veterans of the Indian and Civil Wars and to pioneers (ch. 56); authorizing the governor to suspend the hunting season in case of drouth (ch. 76); amending the game law generally (ch. 297); removing protection from beaver in Benton and Marion Counties (ch. 340); establishing a game refuge in Multnomah and Clackamas Counties (ch. 402); providing special seasons for certain counties in eastern Oregon (ch. 416).

Pennsylvania.—Four acts: Amending the license law imposing a penalty of $25 for hunting without a license if no game has been killed, with additional penalties in case certain kinds of game have been killed, providing that guns and shooting paraphernalia used by offenders may be seized and sold if fines and costs are not paid (No. 86); amending the law requiring game protectors to enforce the laws relating to forestry, fish, and game (No. 172); providing for the establishment of auxiliary State game preserves on private lands comprising not less than 250 nor more than 2,000 acres (No. 182); a comprehensive act codifying the game law, changing the seasons and continuing the open season for rabbits during the first two weeks of December after the close of the season for upland birds, fixing bag limits, regulating sale and shipment, establishing preserves, etc., and providing that an offender convicted of a second offense under the game laws shall be imprisoned one day for each dollar of penalty imposed and denied the right to hunt for two years (No. 199).

Rhode Island.—Two acts: Authorizing the commissioners of birds to grant licenses without charge to raise game in captivity, which may be sold for propagation under regulations of the commission (ch. 1513); amending the game law by providing that commissioners and their deputies shall not be liable for costs when making complaints of violations of the law; authorizing the appointment of any number of deputies with authority to arrest without warrant (ch. 1535).

South Carolina.—One general and 11 local acts: Taxing holders of game preserves in excess of 5,000 acres (except in Berkeley County) as follows: 5,000

to 30,000 acres, 2 cents per acre; 30,000 to 55,000 acres, 4 cents per acre; 55,000 or more, 5 cents per acre, licenses to be collected by county treasurer and proceeds expended on highways of the county (No. 97); changing the seasons for deer in Dillon County (No. 27); Georgetown County (No. 190); Jasper and Hampton Counties (No. 102); repealing laws protecting deer in Bamberg and Orangeburg (No. 103), and in Sumter County (No. 104); changing the season on partridges in Abbeville (No. 36), Cherokee (No. 99), and Chesterfield Counties (No. 100), and in counties containing cities of more than 50,000 inhabitants (No. 16); reducing the bag limit on partridges in counties containing cities of 50,000 or more inhabitants (No. 31); exempting Jasper County and Bluffton and Yemassee Townships in Beaufort County from the hunting-license law (No. 102).

South Dakota.—Eight acts: Providing for the elimination of private holdings from the State game preserve by authorizing exchange for State capitol building lands (ch. 388); modifying the season on prairie chickens and grouse by opening 3 days earlier and making the season on waterfowl and snipe uniform with Federal law; reducing bag limits on waterfowl from 20 to 15 a day and limit in possession from 50 to 35 and on other birds from 10 to 5 a day and from 25 to 15 in possession; and permitting transportation of birds under nonresident license coupons (ch. 244); regulating distribution of licenses for sale (ch. 247); empowering game wardens to enforce laws on boundary waters, extending jurisdiction of courts, and recognizing concurrent jurisdiction of courts and administrative officers of Minnesota, North Dakota, and Iowa over boundary waters (ch. 248); authorizing five additional game wardens and the employment of an attorney to prosecute violations when deemed necessary, and prohibiting State warden from expending more than $200 without consent of commission (ch. 249); authorizing game and fish commission to acquire property for propagation of game and fish by purchase or condemnation (ch. 250); increasing salary of State warden from $1,500 to $2,400 per annum (ch. 251); authorizing the establishment and protection of game refuges upon petition of one or more landowners in the locality affected (ch. 252).

Tennessee.—Five general acts: Ceding to the Federal Government the right to conserve game and fish on lands acquired by it for the protection of watersheds (ch. 45); conforming open seasons to Federal regulations (chs. 9, 95); special law relating to hunting on Reelfoot Lake (ch. 122); ratifying action of State game warden in creating "the Appalachian Fish and Game Preserve No. 1," providing for its maintenance, and prescribing penalties (ch. 131). Thirty-five local acts.

Texas.—Two acts: Prohibiting killing of antelope, sheep, and mountain goats for a period of 25 years under a fine of $500 to $1,000 and 30 to 60 days' imprisonment (ch. 69); exempting buffalo and catalo in captivity from taxation (ch. 172).

Utah.—General revision of the game law, closing deer season to 1920, and prohibiting all hunting of quail, sage hen, grouse, and dove (ch. 79); prohibiting aliens from hunting or having firearms in possession (ch. 95).

Vermont.—Five acts: Amending law in regard to issuing licenses (No. 203); providing for certificates of registration where licenses have been lost (No. 205); making State season on waterfowl uniform with Federal law (No. 216); shortening deer season from 3 weeks to 10 days (No. 217); removing bounty on black bears (No. 220).

Virginia.—No session of the legislature.

Washington.—Providing for the Okanogan Game Preserve of 7,280 acres (ch. 91); amending the game law (ch. 164).

West Virginia.—No legislation.

Wisconsin.—One general act codifying and amending the game laws; repealing the doe law; shortening the open season on deer; providing a general open season on squirrels; establishing close season on partridges, or ruffed grouse, and spruce hen, and on prairie chickens and pinnated and sharp-tailed grouse until 1919; repealing law prohibiting hunting wild geese and brant on Mississippi River; changing closing date on wild ducks; authorizing seizures of all vehicles, including automobiles, containing game illegally in possession (ch. 666).

Wyoming.—Three acts: Authorizing cities and towns to establish zoological gardens, and the game commission to supply birds and animals therefor (ch. 40); amending the law relative to State game preserves, eliminating the eastern part of the Teton Preserve and the southern part of the Big Horn Preserve, and establishing 6 new game preserves (making 11 in all), namely, Carter Mountain, in Park County; Days River, in Lincoln County; Wind River, in Fremont County; Careyhurst, in Converse County; Bridger, in Lincoln County; and Kendall, in Sweetwater County (ch. 108); and a memorial protesting against the enactment of any legislation by Congress to establish game sanctuaries in national forests (H. J. Memorial No. 1).

CANADA.

Dominion legislation.—One act: A comprehensive migratory-birds convention act to carry into effect the treaty for the protection of migratory birds in the United States and Canada; authorizing the governor in council to make necessary regulations for the protection of migratory game, insectivorous, and nongame birds; authorizing the minister of the interior to appoint game officers to enforce the act; providing for seizure and confiscation of boats, teams, and hunting paraphernalia used in violation of the act; authorizing search and providing penalties for violation of the act or for anyone assaulting or interfering with a game officer in the discharge of his duty (H. B. 92, 7th sess., 12th Parl., 7–8 George V).

Alberta.—One act: Extending the close season on antelope until 1925; modifying the provision relative to migratory birds to conform with the migratory-bird treaty; closing the season on grouse, partridges, pheasants, ptarmigan, and prairie chickens until 1918; extending protection to wild geese (ch. 35).

British Columbia.—By regulation: Changing seasons on deer west of Cascade Range, except on Queen Charlotte Islands; changing open season on geese, ducks and shore birds on Vancouver Island and the Islands electoral district and adjacent waters and other districts east of Cascade Range, and throughout rest of Province; also on blue grouse west of Cascade Range; on quail in district municipality of Penticton; on ruffed grouse and pheasants in several electoral districts; on European partridges in Delta electoral district; and prohibiting killing of pheasants when snow is on the ground.

Manitoba.—One act: Closing the season on elk, grouse, and prairie chickens and establishing two new game preserves, known as the Birch Island and Lake Winnipegosis Game Preserves, and eliminating small areas in the Riding Mountain and Red Deer Preserves (ch. —).

New Brunswick.—One act: Amending several sections of the game law, protecting wood duck, making a special open season for black ducks, September 15 to December 1; repealing the provision allowing eggs of sea gulls to be taken prior to June 24; permitting a nonresident holding a big-game license to hunt game birds without a special license; reducing the fee for resident license for hunting big game from $3 to $2; raising the age limit for issuing licenses to minors from 16 to 18 years; and authorizing the minister of lands and mines to issue permits to anyone to keep in cold storage for his personal use any game animal or bird during the close season (ch. 24).

Nova Scotia.—No legislation.

Ontario.—One act: Amending game and fisheries act authorizing the lieutenant governor in council to make such regulations to give effect to any treaty which has heretofore been or may hereafter be entered into between Great Britain and the United States for fixing or changing seasons for hunting game birds or animals, prohibiting or regulating the purchase, sale, or traffic in game birds or animals, etc. (sec. 1); providing that such regulations when made will supersede all statutes or regulations affecting game (sec. 2); opening the hunting season for big game north of the Government railway on October 10 instead of November 1 (sec. —).

Prince Edward Island.—No legislation.

Quebec.—One act: Adding the American eider duck, the gannet, puffin or sea parrot, and the guillemot or sea pigeon to the list of protected birds.

Saskatchewan.—One act: Adding the little brown, sandhill, and whooping or white cranes to list of protected birds having no open season; placing certain birds of the order Limicolæ on the protected list; establishing a close season on any bird of the order Gallinæ, excepting ptarmigan, until September 15, 1918; giving protection at all times to females of all big game animals.

LACEY ACT, REGULATING INTERSTATE COMMERCE IN GAME.

Federal laws affecting the shipment of game comprise statutes regulating interstate commerce in game and the importation of birds and mammals from foreign countries, as follows:

ACT OF MARCH 4, 1909.

(35 Stat., 1137.)

The importation of certain injurious animals and birds; permits for foreign wild animals and birds; cage birds, specimens for museums, etc.

SEC. 241. The importation into the United States, or any Territory or District thereof, of the mongoose, the so-called "flying foxes," or fruit bats, the English sparrow, the starling, and such other birds and animals as the Secretary of Agriculture may from time to time declare to be injurious to the interests of agriculture or horticulture, is hereby prohibited; and all such birds and animals shall, upon arrival at any port of the United States, be destroyed or returned at the expense of the owner. No person shall import into the United States or into any Territory or District thereof any foreign wild animal or bird, except under special permit from the Secretary of Agriculture: *Provided*, That nothing in this section shall restrict the importation of natural-history specimens for museums or scientific collections, or of certain cage birds, such as domesticated canaries, parrots, or such other birds as the Secretary of Agriculture may designate. The Secretary of the Treasury is hereby authorized to make regulations for carrying into effect the provisions of this section.

Interstate transportation of animals and birds illegally imported and game killed or shipped in violation of State laws; transportation of game in season; feathers of barnyard fowls.

SEC. 242. It shall be unlawful for any person to deliver to any common carrier for transportation, or for any common carrier to transport from any

State, Territory, or District of the United States, to any other State, Territory, or District thereof, any foreign animals or birds, the importation of which is prohibited, or the dead bodies or parts thereof of any wild animals or birds, where such animals or birds have been killed or shipped in violation of the laws of the State, Territory, or District in which the same were killed, or from which they were shipped: *Provided*, That nothing herein shall prevent the transportation of any dead birds or animals killed during the season when the same may be lawfully captured, and the export of which is not prohibited by law in the State, Territory, or District in which the same are captured or killed: *Provided further*, That nothing herein shall prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowls.

Marking of packages containing bodies or plumage of game animals or game or other wild birds.

SEC. 243. All packages containing the dead bodies, or the plumage, or parts thereof, of game animals, or game or other wild birds, when shipped in interstate or foreign commerce, shall be plainly and clearly marked, so that the name and address of the shipper, and the nature of the contents, may be readily ascertained on an inspection of the outside of such package.

Penalty for violations of sections 241 to 244.

SEC. 244. For each evasion or violation of any provision of the three sections last preceding, the shipper shall be fined not more than $200; the consignee knowingly receiving such articles so shipped and transported in violation of said sections shall be fined not more than $200; and the carrier knowingly carrying or transporting the same in violation of said sections shall be fined not more than $200.

ACT OF MAY 25, 1900.

(31 Stat., 188.)

Bodies of game animals and game and song birds subject to laws of State, etc., into which transported.

SEC. 5. That all dead bodies, or parts thereof, of any foreign game animals, or game or song birds, the importation of which is prohibited, or the dead bodies, or parts thereof, of any wild game animals, or game or song birds transported into any State or Territory, or remaining therein for use, consumption, sale, or storage therein, shall upon arrival in such State or Territory be subject to the operation and effect of the laws of such State or Territory enacted in the exercise of its police powers, to the same extent and in the same manner as though such animals or birds had been produced in such State or Territory, and shall not be exempt therefrom by reason of being introduced therein in original packages or otherwise. This act shall not prevent the importation, transportation, or sale of birds or bird plumage manufactured from the feathers of barnyard fowl.

TARIFF ACT, PROHIBITING IMPORTATION OF PLUMAGE.

ACT OF OCTOBER 3, 1913.

(38 Stat., 148.)

PAR. 347. Feathers and downs, on the skin or otherwise, crude or not dressed, colored, or otherwise advanced or manufactured in any manner, not specially provided for in this section, twenty per centum ad valorem; when dressed, colored,

or otherwise advanced or manufactured in any manner, and not suitable for use as millinery ornaments, including quilts of down and manufacture of down, forty per centum ad valorem; artificial or ornamental feathers suitable for use as millinery ornaments, artificial and ornamental fruits, grains, leaves, flowers, and stems or parts thereof, of whatever material composed, not specially provided for in this section, sixty per centum ad valorem; boas, boutonnières, wreaths, and all articles not specially provided for in this section, composed wholly or in chief value of any of the feathers, flowers, leaves, or other material herein mentioned, sixty per centum ad valorem: *Provided*, That the importation of aigrettes, egret plumes or so-called osprey plumes, and the feathers, quills, heads, wings, tails, skins, or parts of skins, of wild birds, either raw or manufactured, and not for scientific or educational purposes, is hereby prohibited; but this provision shall not apply to the feathers or plumes of ostriches, or to the feathers or plumes of domestic fowls of any kind.

LAW PROTECTING BIRDS AND THEIR EGGS ON FEDERAL BIRD RESERVATIONS.

ACT OF MARCH 4, 1909.

(35 Stat., 1104.)

SEC. 84. Whoever shall hunt, trap, capture, willfully disturb, or kill any bird of any kind whatever, or take the eggs of any such bird, on any lands of the United States which have been set apart or reserved as breeding grounds for birds, by any law, proclamation, or executive order, except under such rules and regulations as the Secretary of Agriculture may, from time to time, prescribe, shall be fined not more than $500, or imprisoned not more than six months, or both.

REGULATIONS FOR THE PROTECTION OF MIGRATORY BIRDS.

BY THE PRESIDENT OF THE UNITED STATES OF AMERICA, A PROCLAMATION.[1]

Whereas an act of Congress approved March 4, 1913, entitled "An act making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and fourteen" (37 Stat., 847), contains provisions as follows:

All wild geese, wild swans, brant, wild ducks, snipe, plover, woodcock, rail, wild pigeons, and all other migratory game and insectivorous birds which in their northern and southern migrations pass through or do not remain permanently the entire year within the borders of any State or Territory, shall hereafter be deemed to be within the custody and protection of the Government of the United States, and shall not be destroyed or taken contrary to regulations hereinafter provided therefor.

The Department of Agriculture is hereby authorized and directed to adopt suitable regulations to give effect to the previous paragraph by prescribing and fixing closed seasons, having due regard to the zones of temperature, breeding habits, and times and line of migratory flight, thereby enabling the department to select and designate suitable districts for different portions of the country, and it shall be unlawful to shoot or by any device kill or seize and capture migratory birds within the protection of this law during said closed seasons,

[1] 38 Stat., 1960, as amended by proclamation of August 21, 1916, 39 Stat., Proc., 72.

and any person who shall violate any of the provisions or regulations of this law for the protection of migratory birds shall be guilty of a misdemeanor and shall be fined not more than $100 or imprisoned not more than ninety days, or both, in the discretion of the court.

The Department of Agriculture, after the preparation of said regulations, shall cause the same to be made public, and shall allow a period of three months in which said regulations may be examined and considered before final adoption, permitting, when deemed proper, public hearings thereon, and after final adoption shall cause the same to be engrossed and submitted to the President of the United States for approval: *Provided, however*, That nothing herein contained shall be deemed to affect or interfere with the local laws of the States and Territories for the protection of nonmigratory game or other birds resident and breeding within their borders, nor to prevent the States and Territories from enacting laws and regulations to promote and render efficient the regulations of the Department of Agriculture provided under this statute.

Whereas, the Department of Agriculture has duly prepared suitable regulations to give effect to the foregoing provisions of said act and after the preparation of said regulations has caused the same to be made public and has allowed a period of three months in which said regulations might be examined and considered before final adoption and has permitted public hearings thereon;

And, Whereas, the Department of Agriculture has adopted the regulations hereinafter set forth, and after final adoption thereof has caused the same to be engrossed and submitted to the President of the United States for approval;

Now, Therefore, I, Woodrow Wilson, President of the United States of America, by authority in me vested do approve and hereby proclaim and make known the following regulations for carrying into effect the foregoing provisions of said act:

REGULATION 1.—DEFINITIONS.

For the purposes of these regulations the following shall be considered migratory game birds:

(*a*) Anatidæ, or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidæ, or cranes, including little brown, sandhill, and whooping cranes.

(*c*) Rallidæ, or rails, including coots, gallinules, and sora and other rails.

(*d*) Limicolæ, or shore birds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plover, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.

(*e*) Columbidæ, or pigeons, including doves and wild pigeons.

For the purposes of these regulations the following shall be considered migratory insectivorous birds:

(*f*) Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, hummingbirds, kinglets, martins, meadowlarks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwills, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects.

REGULATION 2.—CLOSED SEASON AT NIGHT.[1]

A daily closed season on all migratory game and insectivorous birds shall extend from sunset to sunrise.

REGULATION 3.—CLOSED SEASON ON INSECTIVOROUS BIRDS.

A closed season on migratory insectivorous birds shall continue throughout each year, except that the closed season on reedbirds or ricebirds in New Jersey, Pennsylvania, Delaware, Maryland, the District of Columbia, Virginia, North Carolina, South Carolina, and Georgia shall commence November 1 and end August 31, next following, both dates inclusive: *Provided*, That nothing in this or any other of these regulations shall be construed to prevent the issue of permits for collecting birds for scientific purposes in accordance with the laws and regulations in force in the respective States and Territories and the District of Columbia.

REGULATION 4.—CLOSED SEASONS ON CERTAIN GAME BIRDS.

A closed season shall continue until September 1, 1918, on the following migratory game birds: Band-tailed pigeons, little brown, sandhill, and whooping cranes, wood ducks, swans, curlew, willet, and all shore birds except the black-breasted and golden plover, Wilson snipe or jacksnipe, woodcock, and the greater and lesser yellowlegs.

A closed season also shall continue until September 1, 1918, on rails in California and Vermont and until October 1, 1918, on woodcock in Illinois, Kentucky, and Missouri, and until September 1, 1918, on black-breasted and golden plover and greater and lesser yellowlegs in California and Utah.

REGULATION 5.—ZONES.

The following zones for the protection of migratory game and insectivorous birds are hereby established:

Zone No. 1, the breeding zone, comprising the States of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Kentucky, West Virginia, Michigan, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Nebraska, Kansas, Missouri, Colorado, Wyoming, Montana, Idaho, Utah, Nevada, Oregon, and Washington—31 States.

Zone No. 2, the wintering zone, comprising the States of Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana. Texas, Oklahoma, New Mexico, Arizona, and California—17 States and the District of Columbia.

REGULATION 6.—CONSTRUCTION.

For the purpose of regulations 7 and 8 each period of time therein prescribed as a closed season shall be construed to include the first and last day thereof.

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[1] The following amendment was proposed and issued July 9, 1917, and approved by the President October 10, 1917:

"A daily closed season on all migratory game and insectivorous birds shall extend from sunset to half an hour before sunrise."

REGULATION 7.—CLOSED SEASONS IN ZONE NO. 1.[1]

Waterfowl, coots, and gallinules.—The closed seasons on waterfowl, coots, and gallinules in zone 1 shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, New York (except Long Island), Ohio, Michigan, Indiana, Kentucky, West Virginia, Illinois, Iowa, Kansas, Nebraska, and Missouri the closed season shall be between January 1 and September 15 next following;

In Wisconsin, Minnesota, North Dakota, South Dakota, Montana, Idaho, Wyoming, and Colorado the closed season shall be between December 21 and September 6 next following; and

In Rhode Island, Connecticut, Long Island, New Jersey, Pennsylvania, Washington, Oregon, Utah, and Nevada the closed season shall be between January 16 and September 30 next following.

Rails, other than coots and gallinules.—The closed season on sora and other rails, excluding coots and gallinules, in zone 1 shall be between December 1 and August 31 next following, except as follows:

Exception: In Vermont the closed season shall continue until September 1, 1918.

Black-breasted and golden plover and greater and lesser yellowlegs.—The closed seasons on black-breasted and golden plover and greater and less yellowlegs in zone 1 shall be as follows:

In Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey the closed season shall be between December 1 and August 15 next following;

In Vermont, Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Illinois, Iowa, Missouri, Kansas, Nebraska, Colorado, and Nevada the closed season shall be between December 16 and August 31 next following;

In Wisconsin, Minnesota, North Dakota, South Dakota, Montana, Idaho, and Wyoming the closed season shall be between December 21 and September 6 next following;

In Oregon and Washington the closed season shall be between December 16 and September 30 next following; and

In Utah the closed season shall continue until September 1, 1918.

Jacksnipe.—The closed seasons on jacksnipe or Wilson snipe in zone 1 shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, New York (except Long Island), Ohio, West Virginia, Kentucky, Indiana, Michigan, Illinois, Iowa, Missouri, Kansas, and Nebraska the closed season shall be between January 1 and September 15 next following;

In Rhode Island, Connecticut, Long Island, New Jersey, Pennsylvania, Washington, Oregon, Nevada, and Utah the closed season shall be between January 16 and September 30 next following; and

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[1] The following amendment was proposed and issued July 9, 1917, and approved by the President October 10, 1917:

"*Waterfowl, coot, and gallinules.*—The closed seasons on waterfowl, coot, and gallinules shall be as follows:

"In Maine, New Hampshire, Vermont, Massachusetts, New York (except Long Island), Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Michigan, Wisconsin, Illinois, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Montana, Idaho, Nevada, and that portion of the States of Oregon and Washington lying east of the summit of the Cascade Mountains the closed season shall be between Jan. 1 and Sept. 15 next following; and

"In Rhode Island, Connecticut, that portion of New York known as Long Island, New Jersey, Utah, and that portion of the States of Oregon and Washington lying west of the summit of the Cascade Mountains the closed season shall be between Jan. 16 and Sept. 30 next following."

In Wisconsin, Minnesota, North Dakota, South Dakota, Montana, Idaho, Wyoming, and Colorado the closed season shall be between December 21 and September 6 next following.

Woodcock.—The closed season on woodcock in zone 1 shall be between December 1 and September 30 next following, except as follows:

Exceptions: In Illinois, Kentucky, and Missouri the closed season shall continue until October 1, 1918.

REGULATION 8.—CLOSED SEASONS IN ZONE NO. 2.

Waterfowl, coots, and gallinules.—The closed seasons on waterfowl, coots, and gallinules in zone 2 shall be as follows:

In Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana the closed season shall be between February 1 and October 31 next following; and

In Oklahoma, Texas, New Mexico, Arizona, and California the closed season shall be between February 1 and October 15 next following.

Rails, other than coots and gallinules.—The closed season on sora and other rails, excluding coots and gallinules, in zone 2 shall be between December 1 and August 31 next following, except at follows:

Exceptions: In Louisiana the closed season shall be between February 1 and October 31; and

In California the closed season shall continue until September 1, 1918.

Black-breasted and golden plover and greater and lesser yellowlegs.—The closed seasons on black-breasted and golden plover and greater and lesser yellowlegs in zone 2 shall be as follows:

In Delaware, Maryland, District of Columbia, and Virginia the closed season shall be between December 1 and August 15 next following;

In South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas the closed season shall be between February 1 and October 31 next following;

In North Carolina, Tennessee, Arkansas, Oklahoma, New Mexico, and Arizona the closed season shall be between December 16 and August 31 next following; and

In California the closed season shall continue until September 1, 1918.

Jacksnipe.—The closed seasons on jacksnipe or Wilson snipe in zone 2 shall be as follows:

In Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, and Louisiana the closed season shall be between February 1 and October 31 next following; and

In Oklahoma, Texas, New Mexico, Arizona, and California the closed season shall be between February 1 and October 15 next following.

Woodcock.—The closed season on woodcock in zone 2 shall be between January 1 and October 31 next following.

REGULATION 9.—HEARINGS.

Persons recommending changes in the regulations or desiring to submit evidence in person or by attorney as to the necessity for such changes should make application to the Secretary of Agriculture. Hearings will be arranged and due notice thereof given by publication or otherwise as may be deemed appropriate. Persons recommending changes should be prepared to show the

necessity for such action and to submit evidence other than that based on reasons of personal convenience or a desire to kill game during a longer open season.

REPEAL.

Except in respect to offenses theretofore committed, on and after the date of the approval by the President of the foregoing regulations such regulations shall supersede the regulations for the protection of migratory birds approved and proclaimed October 1, 1913 (38 Stat., 1960), as amended by regulations for the protection of migratory birds approved and proclaimed August 31, 1914 (38 Stat., 2024), as further amended by regulations for the protection of migratory birds approved and proclaimed October 1, 1914 (38 Stat., 2032).

In witness whereof I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the city of Washington this twenty-first day of August, in the year of our Lord one thousand nine hundred and [SEAL.] sixteen, and of the independence of the United States the one hundred and forty-first.

WOODROW WILSON.

By the President:

ROBERT LANSING,
Secretary of State.

CONVENTION BETWEEN THE UNITED STATES AND GREAT BRITAIN FOR THE PROTECTION OF MIGRATORY BIRDS IN THE UNITED STATES AND CANADA.[1]

Whereas many species of birds in the course of their annual migrations traverse certain parts of the United States and the Dominion of Canada; and

Whereas many of these species are of great value as a source of food or in destroying insects which are injurious to forests and forage plants on the public domain, as well as to agricultural crops, in both the United States and Canada, but are nevertheless in danger of extermination through lack of adequate protection during the nesting season or while on their way to and from their breeding grounds;

The United States of America and His Majesty the King of the United Kingdom of Great Britain and Ireland and of the British dominions beyond the seas, Emperor of India, being desirous of saving from indiscriminate slaughter and of insuring the preservation of such migratory birds as are either useful to man or are harmless, have resolved to adopt some uniform system of protection which shall effectively accomplish such objects, and to

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[1] This treaty was signed on August 16, ratified by the Senate August 29, by the President September 1, and by Great Britain October 20; ratifications thereof were exchanged December 7, and it was proclaimed by the President December 8, 1916.

Canada, by an act of Parliament approved August 29, 1917, gave full effect to this convention. (See p. 67.)

The Constitution of the United States contains the following provision in regard to treaties:

"This Constitution, and the laws of the United States which shall be made in pursuance thereof; and all treaties made, or which shall be made, under the authority of the United States shall be the supreme law of the land; and the judges in every State shall be bound thereby, anything in the constitution or laws of any State to the contrary notwithstanding." (Art. VI, par. 2.)

the end of concluding a convention for this purpose have appointed as their respective plenipotentiaries:

The President of the United States of America, Robert Lansing, Secretary of State of the United States; and

His Britannic Majesty, the Right Honorable Sir Cecil Arthur Spring Rice, G. C. V. O., K. C. M. G., etc., His Majesty's ambassador extraordinary and plenipotentiary at Washington;

Who, after having communicated to each other their respective full powers, which were found to be in due and proper form, have agreed to and adopted the following articles:

ARTICLE I.

The High Contracting Powers declare that the migratory birds included in the terms of this convention shall be as follows:

1. Migratory game birds:

(*a*) Anatidæ, or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidæ, or cranes, including little brown, sandhill, and whooping cranes.

(*c*) Rallidæ, or rails, including coots, gallinules, and sora, and other rails.

(*d*) Limicolæ, or shorebirds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.

(*e*) Columbidæ, or pigeons, including doves and wild pigeons.

2. Migratory insectivorous birds: Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, humming birds, kinglets, martins, meadowlarks, nighthawks or bull bats, nut-hatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwills, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects.

3. Other migratory nongame birds: Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

ARTICLE II.

The High Contracting Powers agree that, as an effective means of preserving migratory birds there shall be established the following close seasons during which no hunting shall be done except for scientific or propagating purposes under permits issued by proper authorities.

1. The close season on migratory game birds shall be between March 10 and September 1, except that the close season on the Limicolæ, or shorebirds, in the maritime Provinces of Canada and in those States of the United States bordering on the Atlantic Ocean, which are situated wholly or in part north of Chesapeake Bay shall be between February 1 and August 15, and that Indians may take at any time scoters for food but not for sale. The season for hunting shall be further restricted to such period not exceeding three and one-half months as the High Contracting Powers may severally deem appropriate and define by law or regulation.

2. The close season on migratory insectivorous birds shall continue throughout the year.

3. The close season on other migratory nongame birds shall continue throughout the year, except that Eskimos and Indians may take at any season auks, auklets, guillemots, murres, and puffins, and their eggs, for food and their skins for clothing, but the birds and eggs so taken shall not be sold or offered for sale.

ARTICLE III.

The High Contracting Powers agree that during the period of 10 years next following the going into effect of this convention there shall be a continuous close season on the following migratory game birds, to wit:

Band-tailed pigeons; little brown, sandhill, and whooping cranes, swans, curlew and all shorebirds (except the black-breasted and golden plover, Wilson or jacksnipe, woodcock, and the greater and lesser yellowlegs); provided, that during such 10 years the close seasons on cranes, swans, and curlew in the Province of British Columbia shall be made by the proper authorities of that Province within the general dates and limitations elsewhere prescribed in this convention for the respective groups to which these birds belong.

ARTICLE IV.

The High Contracting Powers agree that special protection shall be given the wood duck and the eider duck, either (1) by a close season extending over a period of at least five years, or (2) by the establishment of refuges, or (3) by such other regulations as may be deemed appropriate.

ARTICLE V.

The taking of nests or eggs of migratory game or insectivorous or nongame birds shall be prohibited, except for scientific or propagating purposes, under such laws or regulations as the High Contracting Powers may severally deem appropriate.

ARTICLE VI.

The High Contracting Powers agree that the shipment or export of migratory birds or their eggs from any State or Province, during the continuance of the close season in such State or Province, shall be prohibited except for scientific or propagating purposes, and the international traffic in any birds or eggs at such time captured, killed, taken, or shipped at any time contrary to the laws of the State or Province in which the same were captured, killed, taken, or shipped shall be likewise prohibited. Every package containing migratory birds or any parts thereof or any eggs of migratory birds transported, or offered for transportation from the Dominion of Canada into the United States or from the United States into the Dominion of Canada, shall have the name and address of the shipper and an accurate statement of the contents clearly marked on the outside of such package.

ARTICLE VII.

Permits to kill any of the above-named birds which, under extraordinary conditions, may become seriously injurious to the agricultural or other interests in any particular community, may be issued by the proper authorities of the High Contracting Powers under suitable regulations prescribed therefor by them respectively, but such permits shall lapse, or may be canceled, at any time when, in the opinion of said authorities, the particular exigency has passed, and no birds killed under this article shall be shipped, sold, or offered for sale.

ARTICLE VIII.

The High Contracting Powers agree themselves to take, or propose to their respective appropriate law-making bodies, the necessary measures for insuring the execution of the present convention.

ARTICLE IX.

The present convention shall be ratified by the President of the United States of America, by and with the advice and consent of the Senate thereof, and by His Britannic Majesty. The ratifications shall be exchanged at Washington as soon as possible and the convention shall take effect on the date of the exchange of the ratifications. It shall remain in force for 15 years, and in the event of neither of the High Contracting Powers having given notification, 12 months before the expiration of said period of 15 years, of its intention of terminating its operation, the convention shall continue to remain in force for one year and so on from year to year.

In faith whereof, the respective Plenipotentiaries have signed the present convention in duplicate and have hereunto affixed their seals.

Done at Washington this 16th day of August, 1916.

[SEAL.] ROBERT LANSING.

[SEAL.] CECIL SPRING RICE.

CANADIAN MIGRATORY BIRDS CONVENTION ACT.

(Act of August 29, 1917.)

1. This act may be cited as *The migratory birds convention act.*

2. The said convention of the 16th day of August, 1916, which is set forth in the schedule to this act is hereby sanctioned, ratified, and confirmed.

3. In this act and in any regulation made thereunder, unless the context otherwise requires—

(*a*) "close season" means the period during which any species of migratory game, migratory insectivorous, or migratory nongame bird is protected by this act or any regulation made under this act;

(*b*) "migratory game birds" means—

Anatidæ, or waterfowl, including brant, wild ducks, geese, and swans;

Gruidæ, or cranes, including little brown, sandhill, and whooping cranes;

Rallidæ, or rails, including coots, gallinules, and sora and other rails;

Limicolæ, or shore birds, including avocets, curlew, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs;

Columbidæ, or pigeons, including doves and wild pigeons;

(*c*) "migratory insectivorous birds" means—

Bobolinks, catbirds, chickadees, cuckoos, flickers, flycatchers, grosbeaks, humming birds, kinglets, martins, meadow larks, nighthawks or bull bats, nuthatches, orioles, robins, shrikes, swallows, swifts, tanagers, titmice, thrushes, vireos, warblers, waxwings, whippoorwills, woodpeckers, and wrens, and all other perching birds which feed entirely or chiefly on insects;

(*d*) "migratory nongame birds" means—

Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns;

(*e*) "Minister" means the minister of the interior;

(*f*) "regulation" means any regulation made under the provision of section 4 of this act.

4. (1) The Governor in Council may make such regulations as are deemed expedient to protect the migratory game, migratory insectivorous and migratory nongame birds which inhabit Canada during the whole or any part of the year.

(2) Subject to the provisions of the said convention, such regulations may provide—

(*a*) the periods in each year or the number of years during which any such migratory game, migratory insectivorous or migratory nongame birds shall not be killed, captured, injured, taken, molested, or sold, or their nests or eggs injured, destroyed, taken, or molested;

(*b*) for the granting of permits to kill or take migratory game, migratory insectivorous, and migratory nongame birds, or their nests or eggs;

(*c*) for the prohibition of the shipment or export of migratory game, migratory insectivorous, or migratory nongame birds or their eggs from any Province during the close season in such Province, and the conditions upon which international traffic in such birds shall be carried on;

(*d*) for the prohibition of the killing, capturing, taking, injuring, or molesting of migratory game, migratory insectivorous, or migratory nongame birds, or the taking, injuring, destruction or molestation of their nests or eggs within any prescribed area;

(*e*) for any other purpose which may be deemed expedient for carrying out the intentions of this act and the said convention, whether such other regulations are of the kind enumerated in this section or not.

(3) A regulation shall take effect from the date of the publication thereof in the Canada Gazette, or from the date specified for such purpose in any regulation, and such regulation shall have the same force and effect as if enacted herein, and shall be printed in the prefix in the next succeeding issue of the Dominion statutes, and shall also be laid before both Houses of Parliament within 15 days after the publication thereof if Parliament is then sitting, and if Parliament is not then sitting, within 15 days after the opening of the next session thereof.

5. (1) The Minister may appoint game officers for carrying out this act and the regulations, and may authorize such game officers to exercise the powers of justice of the peace or the powers of a police constable. Such persons shall hold office during pleasure, and shall have, for the purposes of this act and the said convention, such other powers and duties as may be defined by this act and the regulations.

(2) Every game officer who is authorized by the Minister to exercise the powers of a justice of the peace or of a police constable shall, for all the purposes of this act and the regulations, be ex officio a justice of the peace or a police constable, as the case may be, within the district within which he is authorized to act.

(3) Every such game officer shall take and subscribe an oath in the form following, that is to say—

"I, A. B., a ——— of ———, do solemnly swear that to the best of my judgment I will faithfully, honestly and impartially fulfill, execute and perform the office and duties of such ——— according to the true intent and meaning of the migratory birds convention act and the regulations made thereunder.

"So help me God."

6. No one without lawful excuse, the proof whereof shall lie on him, shall buy, sell or have in his possession, any bird, nest or egg or portion thereof during the time when the capturing, killing or taking of such bird, nest or egg, is prohibited by law.

8. All guns, ammunition, boats, skiffs, canoes, punts and vessels of every description, teams, wagons and other outfits, decoys and appliances of every kind, used in violation of or for the purpose of violating this act or any regulation, and any bird, nest or egg taken, caught, killed or had in possession, in violation of this act or any regulation, may be seized and confiscated upon view by

any game officer appointed under this act, or taken and removed by any person for delivery to any game officer or justice of the peace.

8. Any game officer appointed under this act who violates this act or any regulation, or who aids, abets or connives at any violation of this act or of any regulation, shall be liable, upon summary conviction before any recorder, commissioner of police, judge of the sessions of the peace, police stipendiary or district magistrate or any two justices of the peace, to a penalty not exceeding $500 and costs or six months' imprisonment and not less than $100 and costs or three months' imprisonment.

9. Any person who assaults, obstructs or interferes with any game officer or peace officer in the discharge of any duty under the provisions of this act, or of any regulation, shall be guilty of a violation of this act.

10. Any person who willfully refuses to furnish information or willfully furnishes false information to a game officer or peace officer respecting a violation of this act or of any regulation, the existence of or the place of concealment of any bird, nest or egg, or any portion thereof captured, killed or taken in violation of this act or of any regulation, shall be guilty of a violation of this act.

11. Any game officer or peace officer may enter any place or premises in which he has reason to believe there exists migratory game, or migratory insectivorous, or migratory nongame birds, nests or eggs, or any parts thereof, in respect of which a breech of this act or of the regulations may have been committed, and may open and examine any trunk, box, bag, parcel, or receptacle which he has reason to suspect and does suspect contains any such bird, nest or egg, or any part thereof.

12. Every person who violates any provision of this act or any regulation shall, for each offense, be liable upon summary conviction to a fine of not more than $100 and not less than $10, or to imprisonment for a term not exceeding six months, or to both fine and imprisonment.

OFFICIALS FROM WHOM STATE OR PROVINCIAL GAME LAWS MAY BE OBTAINED.

Alabama: State game and fish commissioner, Montgomery.
Alaska: The governor, Juneau; Secretary of Agriculture, Washington, D. C.
Arizona: State game warden, Phoenix.
Arkansas: Secretary, game and fish commission, Little Rock.
California: Executive officer, fish and game commission, New Call Building, San Francisco.
Colorado: State game and fish commissioner, Denver.
Connecticut: Secretary, commission of fisheries and game, Hartford.
Delaware: Chief game warden, Dover.
District of Columbia: Superintendent Metropolitan Police, Washington.
Florida: Secretary of state, Tallahassee.
Georgia: Game and fish commissioner, Atlanta.
Idaho: Fish and game warden, Boise.
Illinois: Chief game and fish warden, Springfield.
Indiana: Commissioner fisheries and game, Indianapolis.
Iowa: State fish and game warden, Spirit Lake.
Kansas: State fish and game warden, Pratt.
Kentucky: Executive agent, game and fish commission, Frankfort.
Louisiana: Commissioner of conservation, Court Building, New Orleans.
Maine: Commissioner of inland fisheries and game, Augusta.
Maryland: State game warden, 512 Munsey Building, Baltimore.
Massachusetts: Chairman, commissioners of fisheries and game, State House, Boston.
Michigan: Commissioner game, fish, and forest-fire department, Lansing.
Minnesota: Game and fish commissioner, St. Paul.
Mississippi: Secretary of state, Jackson.
Missouri: Game and fish commissioner, Jefferson City.
Montana: State game warden, Helena.
Nebraska: Chief deputy, game and fish commission, Lincoln.
Nevada: State fish and game warden, Carson City.
New Hampshre: Fish and game commissioner, Milford.
New Jersey: Secretary, board of fish and game commissioners, Trenton.
New Mexico: Game and fish warden, Santa Fe.
New York: Secretary of conservation commission, Albany.
North Carolina: Secretary, Audubon Society of North Carolina, Raleigh.
North Dakota: Secretary, game and fish board, Steele.
Ohio: Chief game warden, board of agriculture, Columbus.
Oklahoma: State game warden, Oklahoma City.
Oregon: State game warden, Portland.
Pennsylvania: Secretary, board of game commissioners, Harrisburg.
Rhode Island: Chairman, commissioners of birds, Rumford.
South Carolina: Chief game warden, Columbia.
South Dakota: State game warden, Pierre.
Tennessee: State game and fish warden Nashville.
Texas: Game, fish, and oyster commissioner Austin.
Utah: Fish and game commissioner, Salt Lake City.
Vermont: Fish and game commissioner Cambridge.
Virginia: Commissioner of game and inland fisheries, Richmond.
Washington: Chief game warden and State fish commissioner, Seattle; chief deputy game warden, Spokane.
West Virginia: Forest, game, and fish warden, Belington.
Wisconsin: Secretary, conservation commission, Madison.
Wyoming: State game warden,, Lander.

CANADA.

Alberta: Chief game guardian, Edmonton.
British Columbia: Provincial game warden Vancouver.
Manitoba: Chief game guardian, Winnipeg
New Brunswick: Chief game and fire warden, Richibucto.
Newfoundland: Secretary, department of marine and fisheries, St. Johns.
Northwest Territories: Commissioner of Parks, Ottawa.
Nova Scotia: Chief game commissioner, Halifax.
Ontario: Superintendent game and fisheries Toronto.
Prince Edward Island: Game inspector, Charlottetown.
Quebec: General inspector of fisheries and game, Quebec.
Saskatchewan: Chief game guardian, Regina.
Yukon: Territorial secretary, Dawson.

LAWS RELATING TO FUR-BEARING ANIMALS, 1917

A SUMMARY OF LAWS IN THE UNITED STATES AND CANADA RELATING TO TRAPPING, OPEN SEASONS, PROPAGATION, AND BOUNTIES

DAVID E. LANTZ
Assistant Biologist

FARMERS' BULLETIN 911
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief

Washington, D. C. October, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

IN THE fiscal year ended June 30, 1917, the foreign trade of the United States in raw and manufactured furs reached nearly, if not fully, the high level of years preceding the war. The imports were valued at $21,553,375, while the exports amounted to $15,729,160, a sum exceeded in only one previous year, 1913, when they were $18,389,586.

Home manufacture and utilization of American furs has grown enormously since the beginning of the war. The large export trade of the past year shows, therefore, a production of peltries of unprecedented value, in spite of the fact that the actual number of skins collected must have been less than in previous years. Many former trappers were more profitably employed in other industries, and many were deterred from plying their vocation by the increased restrictions on trapping, especially the costly nonresident licenses.

Trapping restrictions properly enforced and limiting the taking of fur to prescribed seasons will result not only in conserving the fur supply but in greatly increasing the quality and value of the annual catch.

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LEGISLATION OF 1917.

ALL the States but Alabama, Louisiana, Kentucky, Mississippi, and Virginia held legislative sessions in 1917, and many changes were made in trapping regulations, seasons for taking fur, and bounty laws.

Arkansas, California, and Oklahoma have been added to the States that protect fur animals. The Arkansas law (1917, No. 133) provides for a trapping license and a close season of 8 months on all fur animals; the season for taking bears is lengthened by 10 days and the absolute protection of beavers and otters is extended to January 1, 1922. The Oklahoma act (1917, H. B. No. 542) protects beavers and otters indefinitely, establishes a close season of 8 months on other fur animals, and makes it unlawful to sell furs taken during the close season.

In California the legislature enacted a general law (A. B. No. 405) providing a close season of 8 months for all fur animals, including black and brown bears. It defines and lists "fur animals," provides a special trapping license (fee, $1; aliens, $2), and requires annual reports from all licensed trappers. It prohibits the use of poisons and protects skunk dens at all times. The law also protects the traps of licensed trappers (1917, ch. 517).

Trapping regulations have been changed or new features added in the session laws of Connecticut, Indiana, Maine, Montana, New Hampshire, New York, Pennsylvania, South Dakota, and Wisconsin.

Arkansas, California, and Montana have been added to the States that require a license for trapping. In South Dakota a license (fee, $5) is now required of both resident and nonresident trappers. A special license (fee, $10) is required to trap beavers in Montana. Nonresidents are obliged to take out a license to trap in Indiana (fee, $15.50) and Pennsylvania (fee, $10). In Oregon and Colorado the fees for licenses have been advanced and in New York the charge for nonresident license has been reduced to $10. Aliens, other than homesteaders, are not permitted to trap in Utah.

Changes in seasons for trapping certain fur animals have been made in Connecticut, Delaware, Indiana, Iowa, Maine, Missouri, Nebraska, North Dakota, Ohio, Pennsylvania, South Dakota, and Wisconsin; also in the Provinces of British Columbia, Manitoba, and Saskatchewan.

Bears have been added to the protected list in California, Minnesota, Montana, Washington, and Wisconsin. The bounty on bears has been repealed in Vermont, but a bounty ($5) has been placed on them in Maine.

Beavers, formerly unprotected in Indiana, are now protected by a close season. In Montana and North Dakota, where they have been protected for several years, they may hereafter be taken under a special license. Protection of beavers has been discontinued in two Oregon counties and an open season for two years provided in three counties of Wisconsin. Prince Edward Island has declared an indefinite close season.

Otters are protected at all times in four additional States—Delaware, Idaho, Minnesota, and Oklahoma.

Skunks have been added to the list of protected species in California, Connecticut, and Wisconsin. They will be protected also in Arkansas and Oklahoma under the term "all fur animals."

Foxes will be protected hereafter in California and Indiana. Fox dens are protected in Maine. Michigan has abolished the close season for foxes and will now pay a bounty for their destruction. Wisconsin also has placed a bounty on these animals.

Raccoons have been added to the protected list in California, Minnesota, and Nebraska and will have a close season also in Arkansas and Oklahoma.

Opossums will hereafter be protected by close seasons in Arkansas, Nebraska, and Oklahoma.

New laws regulating propagation of fur animals have been enacted in Arkansas, Michigan, New Hampshire, Alberta, and Saskatchewan. In Utah the law licensing private otter or beaver preserves has been repealed.

Changes in bounty laws were made in Connecticut, Idaho, Maine, Michigan, Minnesota, Montana, Nevada, New Jersey, Oklahoma,

Oregon, South Dakota, Vermont, Wisconsin, and Wyoming. The changes in Minnesota and New Jersey relate only to manner of proof.

FEDERAL LAWS.

Two Federal laws have a bearing on the fur industry of the United States—the Lacey Act, governing interstate commerce in game, and the tariff act of October 3, 1913.

That part of the Lacey Act codified as section 242 of the Criminal Code (35 Stat., 1137) makes it unlawful to ship or transport "from any State, Territory, or District of the United States, to any other State, Territory, or District thereof" the bodies or parts of bodies of any wild animal or bird killed or shipped in violation of law of the State, Territory, or District in which the same were killed or from which they were shipped. This makes it unlawful to ship out of any State skins or pelts illegally taken. Packages containing furs, when shipped in interstate commerce, must be plainly marked so that the name and address of the shipper and the nature of the contents may be readily ascertained by inspection of the outside of the package.

The tariff act of 1913 places a duty of 10 per cent ad valorem on live animals shipped into the United States. Paragraph 397 of this law places on the free list animals imported for breeding purposes by a citizen of the United States: "*Provided*, That no such animal shall be admitted free unless pure bred of a recognized breed and duly registered in a book of record recognized by the Secretary of Agriculture for that breed." This act has made it impossible thus far to admit free of duty any foxes or other Canadian fur animals for propagation. Raw furs not advanced in manufacture are admitted free of duty.

LAWS OF STATES AND PROVINCES.

The following is a summary by States and Provinces of trapping regulations now in force, open seasons for taking fur animals, provisions relating to their propagation and possession, and to bounties offered for the destruction of predatory species, or those considered harmful. The whole is followed by a brief summary of the protection now given to the more important species.

The laws relating to deer and other big game, rabbits, and squirrels are not considered here, as they appear in the annual game-law bulletin.[1] Those relating to bears are included, mainly because of their connection with bounties.

Throughout the following pages references to legislation give date of law or code, followed by the number of the section, chapter, or

[1] Farmers' Bulletin 910, Game Laws for 1917.

act containing the provision. References are sometimes omitted when provisions from various enactments are grouped in a single sentence or short paragraph.

Under the heading "Trapping" the expression "no legal restrictions" indicates that no specific trapping provisions exist, the general trespass laws of the State not having been considered.

Under the heading "Open seasons" the dates given are, unless otherwise stated, *the first and last days of the open season.*

ALABAMA.

Trapping.—Poisons, drugs, or chemicals may not be used in taking game or fur animals.

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid.

ALASKA.

Trapping.—The Secretary of Commerce makes all regulations for taking fur animals in Alaska. Under regulations published February 1, 1916, it is unlawful to use a "klips" trap, a steel bear trap, or any trap having a spread exceeding 8 inches; to kill any fur-bearing animal with strychnin or other poison; to trap protected fur animals at any time when the skin or pelt is not prime; or to have in possession or sell or export unprime skins of animals protected by close seasons (such skins subject to confiscation). Shipments of furs must be reported to the Bureau of Fisheries, Department of Commerce, on blanks provided for that purpose.

Open seasons.—Land otter and mink, November 16 to March 31; fox and weasel, November 16 to March 14; muskrat, December 1 to May 31; lynx (wildcat), November 16 to February 28 (29). No close season for black bear, wolf, wolverine, ground squirrel, or rabbit.[1] Close season on marten until November 15, 1921; on sea otter until November 1, 1920; on beaver until November 1, 1918. No open seasons in Aleutian Islands Reservation, and trapping may be done there only by special permit.[2]

Propagation.—Owners of establishments for breeding fur animals are subject to the same restrictions as to season for killing and condition of pelts as are trappers of wild fur-bearing animals. Fur farmers are required to furnish reports to the Bureau of Fisheries and to allow agents of that bureau free access to establishments where animals are kept in captivity.

Within the Aleutian Islands Reservation the Department of Agriculture grants permits to propagate fur animals and to trap them for breeding purposes.

Bounties.—Wolf, $10 (session 1915).

ARIZONA.

Trapping.—No legal restrictions except on State game preserves, where mountain lion, fox, coyote, lynx, wildcat, and skunk may be taken under regulations of the State game warden.

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[1] *South of latitude 62°.*—Open season for brown bear, October 1 to July 2. *North of latitude 62°.*—Open season for walrus, May 10 to July 2; no close season for brown bear or sea lion. (35 Stat., 102.)

[2] The fur-seal fisheries, the Aleutian Islands Reservation, and the Afognak Reservation are subject to special legislative and administrative control. For specific information regarding them, application should be made to the Commissioner of Fisheries, Washington, D. C.

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—County boards shall pay, for wolf or mountain lion, $10 each; they may pay, for coyote, $2; lynx or wildcat, $1; raccoon, 25 cents; jack rabbit, gopher, or prairie-dog, 5 cents (1912, ch. 82).

ARKANSAS.

Trapping.—A person using 10 or more traps to take fur animals is required to secure an annual trapper's license (fee, $10). Unlawful to trap bears, to hunt them at night with torch or searchlight, or to sell or exchange the animals (1917, No. 133).

Open seasons.—All fur animals, except beaver, otter, and bear, October 1 to February 28 (29); bear, November 11 to January 10; beaver and otter, no open season before January 1, 1922. Raw skins of fur animals may not be possessed or sold, except between October 1 and March 15. Fur animals found destroying crops or poultry may be killed at any time (1917, No. 133).

Propagation.—The game and fish commission is authorized to issue permits to breeders of game and fur animals under such regulations as it may prescribe (1917, No. 133).

Bounties.—County courts may offer bounty on wolf, wildcat, or panther, and fix the amount of such bounty (1895, No. 44).

CALIFORNIA.

Trapping.—License required of trapper over 18 years old (fee, $1; alien, $2). Licensed trapper is required to report catch before July 1. Fur animals may be killed at any time when destroying property. Unlawful to use poisons in taking fur animals or to dig or smoke out skunks from dens (1917, ch. 517).

Open seasons.—No open season for beaver or sea otter. Open season for black or brown bear, ring-tail cat, coon, pine marten, fisher, wolverine, mink, skunk, river otter, and fox, November 1 to end of February (1917, ch. 517). Seals and sea lions are protected at all times in game district 19 (Penal Code, sec. 637).

Propagation.—No legal restrictions.

Bounties.—Mountain lion, $30, paid by State game commission. Boards of supervisors of counties may at their discretion fix the rate and pay bounty on coyote, wild cat, fox, lynx, bear, or mountain lion. Many counties now pay a bounty on some of these animals, especially on coyotes.[1]

COLORADO.

Trapping.—Hunting license required for trapping; fee, resident, $2; nonresident, $25. Beavers may not be trapped for fur at any time, but the owner of property damaged by the animals may apply to the State game and fish commissioner for a permit to kill them under such regulations as he may provide as to the disposition of the skins (1909, revising secs. 2753, 2759b).

Open seasons.—No close season for fur animals, except beaver.

Propagation.—No legal restrictions, except as to beaver and game animals.

Bounties.—None paid by State since 1895. On petition of 50 freeholders, county commissioners may levy a tax to pay a bounty on coyote, wolf, and mountain lion.

CONNECTICUT.

Trapping.—Unlawful to trap with scented baits (1903, ch. 56); to trap on lands of another without owner's permission (1909, ch. 37); and to take animals with a snare (1913, ch. 79). Traps must be visited at least once in 48

[1] For information in regard to bounties in any county, application should be made to the county clerk.

hours and must not be set in path, wood road, or specially prepared furrow (1917, ch. 403). Hunting license is required for trapping (except on land owned by trapper); fee, resident, $1; nonresident, $10; alien, $15; with an additional 25 cents recording fee for each license. Persons under 16 years of age, while denied a hunting license, may obtain one for taking fur animals only (1917, ch. 153; 1915, ch. 240).

Open seasons.—Otter, November 1 to March 31 (1905, ch. 5); raccoon, October 16 to February 28 (29), but landowner may kill the animals at any time to protect crops (1917, ch. 207); skunk, November 1 to April 30; may be taken at any time to protect property (1917, ch. 43). No close season on other fur animals.

Propagation.—No restrictions on possession or sale of fur animals kept in captivity.

Bounties.—Towns are permitted to pay bounty on wild cat or fox (not over $5) on weasel, woodchuck, wild Belgian hare, or wild German rabbit (not over $1) (1917, ch. 83).

DELAWARE.

Trapping.—Nonresident trappers are required to hold hunting license (fee, $10.50). Unlawful to use pitfall, deadfall, scaffold, cage, snare, trap, net, pen, baited hook, or baited field or any other similar device, or any drug, poison, chemicals, or explosives for taking birds or animals protected by the laws of this State, except muskrats, skunks, minks, and otters, and except as otherwise expressly provided. Traps or other devices unlawfully set are subject to confiscation (Rev. Stat. 1914, sec. 2378). Muskrats may not be taken during the time of any flood or freshet when such flood or freshet may cause them to leave their usual places of shelter and protection (sec. 2387). Muskrats may not be shot at night (sec. 2380) or hunted with a dog (sec. 2388). Unlawful to destroy the nest, den, or lair of any animal protected by law (sec. 2378). Unlawful to hunt, kill, take, or destroy any protected animal, except muskrat, skunk, mink, and otter, while the ground is covered with snow (sec. 2382). Unlawful to shoot at or destroy any fox while such fox is being chased by dog or dogs (sec. 2385). Unlawful to sell or export any fox or fox hides (sec. 2408). Owners of property may at any time destroy fur-bearing animals to protect such property (sec. 2375).

Open seasons.—Skunk and mink, December 1 to March 25; fox, October 1 to April 30; raccoon and opossum, October 1 to February 15; otter, no open season. Muskrat in Kent and Sussex Counties, November 20 to March 25; in Newcastle County, inland and embanked meadows, December 1 to March 25; all other marshes, December 1 to March 10. Muskrat meat may be sold anywhere in the State, November 20 to April 1 (1917, ch. 210, 211).

Propagation.—No restrictions, provided a permit is obtained from the chief game and fish warden (fee, $1). A restricted number of wild fur or game animals for propagating purposes may be taken under permit.

Bounties.—None paid.

DISTRICT OF COLUMBIA.

No legislation relating to fur animals.

FLORIDA.

Trapping.—No legal restrictions.

Open seasons.—Beaver and otter, November 1 to January 31 (1905, No. 57). No close season for other fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid.

GEORGIA.

Trapping.—Permission of owner required to trap on lands of another. Hunting license required to trap outside one's own militia district; fees for State license, nonresident, $15; resident, $3; county license, $1.

Open seasons.—Opossum, October 1 to February 28 (29) (C. Code 1911, sec. 590); fox, Habersham County, September 1 to May 14 (1914, No. 304). Fur animals not otherwise protected.

Propagation.—No restrictions on propagation of unprotected fur animals.

Bounties.—None paid.

HAWAII.

Hawaii has no wild animals valuable for fur. There are no restrictions on the propagation of fur animals, except that mongooses and rabbits may not be kept or bred. Pet rabbits may be raised, if kept in confinement (1905, ch. 37).

IDAHO.

Trapping.—No restrictions, except in State game preserves.

Open seasons.—No open season for otters or beavers, but owner of property destroyed by beavers may obtain a permit to kill them from the State fish and game warden. Skins of animals so killed must be sent to the warden, who shall sell them and apply the proceeds to the State game fund (1911, ch. 62). No close season on other fur animals, except in State game preserves.

In Black Lake Game Preserve, beaver, otter, marten, fisher, fox, mink, and wolverine are protected at all times; mountain lion, bear, lynx, wolf, coyote, and wildcat may be destroyed by game warden or duly authorized person (1915, ch. 9).

In Payette Game Preserve, bear, lynx, wolverine, fox, otter, beaver, marten, mink, and fisher are protected at all times; mountain lion, timber wolf, coyote, and wildcat may be killed by game wardens or duly authorized persons (1909, H. B. 242).

In Big Creek, Selway, and Big Lost River Game Preserves, beaver, otter, marten, fisher, fox, and mink are protected at all times; mountain lion, bear, lynx, wolf, coyote, wolverine, and wildcat may be killed by game wardens or duly authorized persons (1917, chs. 29, 38, 54). In Big Lost River Preserve, badgers, weasels, skunks, and rabbits may be killed by anyone without permit (1917, ch. 29).

Propagation.—No restrictions, except in game preserves.

Bounties.—Coyote, lynx, or wildcat, $2.50 each; bear or wolf, $10; mountain lion, $25; paid from predatory wild animal fund administered through the State live stock sanitary board (1915, ch. 73). Bounty of 2 cents each on pocket gopher, ground squirrel, and prairie-dog; fund raised by taxation; administered like predatory wild animal fund (1917, ch. 102).

ILLINOIS.

Trapping.—No legal restrictions.

Open seasons.—Raccoon, mink, muskrat, skunk, opossum, and otter, November 1 to March 31 (1915, S. B. 439, sec. 4).

Propagation.—Permit is required to conduct a fur farm on which protected animals are reared; fee, $2, and bond of $500 required (1915, S. B. 409).

Bounties.—None paid by State. Counties may at their discretion pay bounty on ground hog and crow (1909, H. B.'s 686, 687).

INDIANA.

Trapping.—Nonresident trapper requires license (fee, $15.50). Trapping o lands of another without written consent of owner, occupant, or lessee unlawful. Traps set on such lands must be placed within burrow of anim or a hollow log and must be visited at least once in each 36 hours (191 ch. 137). Protected fur animals may be killed at any time on one's ow premises to protect property (1911, ch. 6).

Open seasons.—Beaver, raccoon, fox, otter, opossum, and skunk, Novembe 20 to February 1; mink and muskrat, November 1 to March 31 (1917, ch. 137 Muskrat houses protected at all times, except when obstructing ditches watercourses.

Propagation.—All birds and animals raised in captivity are considere domestic stock, and the owner may possess, sell, ship, transport, or otherwis dispose of them without regard to laws regulating the killing and dispositio of wild birds and animals (1915, H. B. 37).

Bounties.—Crow, 10 cents each; may be paid by counties (1911, ch. 133 Boards of county commissioners are authorized at their discretion to pa bounty on wolf, fox, woodchuck, owl, or hawk (Ind. Stat., Burns, sec. 7871).

IOWA.

Trapping.—Hunting license required for trapping; fee, resident, $1; no resident, $10.50 (1915, S. F. 621).

Open seasons.—Beaver, mink, otter, and muskrat, November 15 to March 1 may be destroyed at any time to protect public or private property. Muskra houses are protected at all times. Possession of beaver, mink, otter, or mus rat is lawful only during open season and first five days of close season (191 ch. 396).

Propagation.—No restrictions except as to possession of protected species.

Bounties.—Adult wolf, $20; wolf cub, $4; wildcat, $1; paid by county (191 ch. 189). Boards of supervisors of counties may allow bounty on crow, groun hog, pocket gopher, or rattlesnake.

KANSAS.

Trapping.—The owner or legal occupant of land may destroy fur-bearin animals protected by law when such animals are destroying poultry or damag ing other property (1911, ch. 198).

Open seasons.—Muskrat, skunk, mink, raccoon, opossum, and civet ca November 15 to March 15. No open season for beaver or otter until 192 (1911, ch. 198).

Propagation.—Permits for raising fur animals protected by law are issue by State game warden.

Bounties.—Coyote, $1; wolf, $5; crow and pocket gopher, 5 cents each; pai by county.

KENTUCKY.

Trapping.—Written consent of owner or lessee required to trap on land of another. Traps must be set 18 inches or more within a hole, cave, or ho low log, and must be visited within each 36 hours. Traps set unlawfull may be seized or destroyed by anyone. Fur animals may be killed at an time on one's own premises to protect property (1916, ch. 87).

Open seasons.—Beaver, mink, raccoon, otter, opossum, and skunk, Novembe 15 to December 31; but raccoon, opossum, skunk, and mink may also be take and killed by dog or gun, October 1 to February 15.

Propagation.—No legal restrictions.

Bounties.—None paid.

LOUISIANA.

Trapping.—License for trapping is required; fee, resident, $2; nonresident, $15 (1914, ch. 293). Muskrats may be taken at any time within 6 miles of any levee, and may be killed by the owner of land upon which they are destroying property. Skins of animals killed in open season may be possessed in close season. Wild ducks may not be used for trap bait (1912, ch. 204).

Open seasons.—Bear, November 1 to January 31 (may not be trapped); beaver, muskrat, mink, otter, raccoon, skunk, fox, and opossum, November 1 to February 15 (1912, ch. 204).

Propagation.—No restrictions, except as to capture during close season.

Bounties.—None paid.

MAINE.

Trapping.—Trappers in unorganized townships of the State are required to take out an annual license (fee, $5), and on or before December 15 of each year must make such report as the commissioner of inland fisheries and game may require (1911, ch. 64). Any person who sets a trap in an organized county or incorporated place must obtain written consent of the owner or occupant of land on which the trap is set, and must visit such trap at least once in every 24 hours and remove animals caught (1915, ch. 277). All traps must be plainly marked with owner's name and address, either by having the same stamped on the trap or on a metal tag firmly attached to it (1915, ch. 277). A bear trap must be inclosed in a "hut" and must have a notice that it is set posted conspicuously near it (1915, ch. 277).

Dealers in skins of fur animals must each year take out a license (fee, $2) to engage in this trade and must keep a record of transactions and forward same to the commissioner of inland fisheries and game on or before December 20 (1915, ch. 277). Putting out poison for wolves, foxes, dogs, or other animals is forbidden under penalty of fine or imprisonment (1909, ch. 134).

Traps may not be set within 25 feet of a muskrat house. A special law protects muskrats on Lower Kezar Pond and certain adjacent territory for four years from July 3, 1915 (1915, ch. 19). On complaint by landowners of damage done by beavers, the commissioner of inland fisheries and game has authority to declare an open season for beavers on lands where damage occurs (1915, ch. 222). Any person may lawfully kill any wild animal, except beaver, found destroying his property (1915, ch. 334). Unlawful to dig out a fox den at any time.

Open seasons.—All fur animals (except beaver, muskrat, raccoon, bear, bobcat, Canada lynx (loup cervier), and weasel), October 15 to February 28 (29); muskrat, October 15 to April 30;[1] raccoon, August 15 to February 28 (29). No open season on beaver except when declared by the commissioner of inland fisheries and game. No close season on bear, bobcat, Canada lynx (loup cervier), or weasel (1913, ch. 206).

Propagation.—Permit required to raise fur animals. Protected species may not be captured in close season for stocking fur ranches, and no animals may be imported into the State without permit.

Bounties.—Bobcat and Canada lynx (loup cervier), $4 each; paid by State. Claim for bounty must be made within five days after killing or return from trip on which killing was done (1913, ch. 206). Bounty on bears, $5 each; paid by State, claim to be made within 10 days after killing (1917, ch. 215).

[1] Exception: A special law protects muskrats on Lower Kezar Pond and certain adjacent territory until July 3, 1919.

MARYLAND.

While the State has recently adopted a uniform open season for game, the counties still regulate the taking of fur animals. The State law protecting otter, raccoon, and muskrat between April 1 and January 1 (1900, ch. 371) was amended until it applied to only 6 counties (1912, ch. 843), and some of these have local laws which take precedence. Local laws providing protection to fur animals or regulating their capture are in force in the following counties:

Allegany County.—Raccoon and opossum, open season, September 1 to March 31; hunting license required to capture either (1916, ch. 282). Bounty on wildcat, $2; fox, $1; hawk or hoot owl, 50 cents (1910, ch. 616).

Anne Arundel County.—Raccoon, open season, October 1 to January 31; may not be taken between sunrise and sunset; unlawful to cut down tree to obtain a raccoon (1916, ch. 367); muskrat, open season, December 2 to February 28 (29). Unlawful at any time to destroy muskrat dens or houses, unless the animals are destroying property (1906, ch. 589).

Baltimore County.—Unlawful to set traps, except from November 10 to December 20. Unlawful to pursue or kill raccoons and opossums, except from October 1 to February 28 (inclusive); unlawful to hunt them on Sundays or when snow covers the ground. Permits to take certain predatory fur animals when destroying property may be obtained, but such permits may be revoked at any time by the chief game warden (1912, ch. 751).

Caroline County.—Muskrat, open season, December 15 to March 31; raccoon, September 15 to March 31; otter, December 15 to March 31 (1902, ch. 157). Unlawful for non-residents to trap without license (fee, $4.50). Unlawful to dig into or destroy muskrat homes or dens, except when animals are destroying property (1902, ch. 157). Unlawful to use reflector or artificial light in taking muskrats or otters (1904, ch. 91). Unlawful to kill a fox except by hounds in a hunt or when the fox is destroying poultry (1916, ch. 450).

Carroll County.—Unlawful to kill fox except by hounds in a hunt or when the fox is destroying poultry (1916, ch. 450).

Cecil County.—Muskrat, open season, December 1 to February 28 (29); may be taken only by trapping (1914, ch. 39). Trapping on lands of another without written permission is unlawful (1914, ch. 464).

Charles County.—Unlawful to shoot muskrats on Nanjemoy Creek and tributaries by aid of light (1912, ch. 362).

Dorchester County.—Raccoon and otter, open season, January 1 to March 31 (State law); muskrat, January 1 to March 15 (local law). Unlawful to shoot muskrats (1900, ch. 205) or to use artificial light in taking them. Bounty on crow, 5 cents.

Frederick County.—All fur animals, open season, November 15 to February 28 (29), but night hunting with dogs for raccoon or opossum is lawful at any time (1916, ch. 128.) Bounty on wildcat, $2; mink or fox, $1; weasel, owl, or hawk, 50 cents.

Garrett County.—Bounty on panther or wolf, $20; wildcat, $3; fox, $1; weasel, 50 cents (1916, ch. 13).

Harford County.—Except for muskrats, trapping is forbidden between December 25 and November 15 of the following year. Open season for raccoon, October 2 to November 30. License required to take muskrats or skunks; fee, resident, $1.15; nonresident, $5.15. Unlawful to trap on private property without permission of owner. Bounty of 50 cents each on chicken hawk, pigeon hawk, booby owl, or weasel (1916, ch. 307).

Kent County.—Otter, raccoon, and muskrat, open season, January 1 to March 31 (State law). Unlawful to use light in hunting muskrats.

Montgomery County.—Raccoon and opossum, open season, October 15 to January 14; muskrat, November 15 to February 28 (29). Nonresident requires license to hunt raccoon or opossum (fee, $15.50). Setting a snare or trap in or about a fox den is unlawful. Bounty on hawks, 40 cents (1912, ch. 438).

Prince Georges County.—Unlawful to hunt, shoot, or trap muskrats in Aquasco district, between March 15 and January 1, or to spear them at any time (1910, ch. 688). Raccoon, open season, October 1 to January 31; may not be taken between sunrise and sunset; unlawful to cut down tree to capture raccoon (1916, ch. 376).

Queen Annes County.—Otter, raccoon, and muskrat, open season, January 1 to March 31 (State law).

Somerset County.—Otter and raccoon, open season, January 1 to March 31 (State law); muskrat, January 1 to March 15 (local law). Unlawful at any time to shoot muskrats.

Talbot County.—Otter and muskrat, open season, December 16 to March 15. Dealers may have skins of either in possession up to March 31. Unlawful to take otter or muskrat at night, except in traps (1912, ch. 785).

Washington County.—Muskrat, mink, skunk, opossum, and otter, open season, December 1 to March 31 (1916, ch. 320). Unlawful to shoot foxes while they are being chased by dogs.

Wicomico County.—Otter, mink, and muskrat, open season, December 15 to February 28 (29). Unlawful to use light in hunting muskrats (1894, ch. 51).

Worcester County.—Muskrat, otter, and mink, open season, December 15 to February 28 (29). Unlawful to trap on lands or marshes of another without permission (1910, ch. 239). Unlawful to chase fox with dogs, March 10 to August 31, or to shoot any fox while it is pursued by dogs (1904, ch. 652).

MASSACHUSETTS.

Trapping.—Poison may not be used to kill animals, except rats, woodchucks, or other pests on one's own premises. The use of steel traps with spread of over 6 inches and "choke" traps with greater opening than 6 inches is unlawful, as is also the use of wire snares or of scented baits. Traps may not be set on lands of another without written consent. Traps must be visited at least once in 24 hours. Introduction of foxes or raccoons into Dukes County is prohibited (Rev. Laws 1902–1908, ch. 92).

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—Wildcat or lynx, $5; paid by town, but refunded by county (1903, ch. 344).

MICHIGAN.

Trapping.—License required for trapping; fee, resident, $1; nonresident, $10 (1917, No. 267). A special license (fee, $10) is required for trapping beavers. Such license permits the taking of 15 beavers, not more than 4 from a single colony. Unlawful to destroy beaver houses or dams or to have carcass or skin in possession without license seal attached (1911, No. 206). Unlawful to molest dens of fur animals or to use spears, explosives, chemicals, mechanical devices, or smokers to drive animals from their holes or homes; unlawful to destroy beaver, muskrat, or skunk den or home, to shoot muskrats, or to set a trap within 6 feet of a muskrat house or hole, or to possess carcass or skin of fur animal killed in close season (1917, ch. 186). Fur animals, except beavers, may be destroyed on one's own premises to protect property (1909, No. 183). Unlawful to trap on State game refuges (1913, No. 360.)

Open seasons.—Beaver (under special license), November 1 to May 14; muskrat, skunk, otter, mink, fisher, marten, and raccoon November 16 to March 14 (1917, No. 186). No close season for wolf, fox, lynx, and wildcat.

Propagation.—Annual license (fee, $5) required to engage in raising fur animals. Live animals and skins of animals raised in captivity must be tagged (fee, 5 cents for each tag) (1917, No. 311).

Bounties.—Wolf, $35; wolf cub under 6 months, $15; coyote, same as wolf; wildcat or lynx, $5; fox, $1; weasel, hawk, or owl, 50 cents; paid by county, half refunded by State. Boards of supervisors may pay additional bounties (1917, No. 315).

MINNESOTA.

Trapping.—Unlawful to molest or destroy muskrat, mink, or beaver house or den at any time or to hunt these animals with dog, or dogs, provided, that in the open season for muskrats their houses may be opened to set traps, but not in such manner as to injure them as habitations for muskrats. If any of these animals are damaging property the owner may obtain a permit to kill them and destroy their houses or dams. Nonresidents must obtain license to trap mink, beaver, muskrat, or otter; fee, $10. Skins or pelts legally taken may be possessed, bought, or sold at any time (1913, ch. 32, sec. 4796).

Open seasons.—No open season for beaver or otter; mink and muskrat, December 1 to April 15 (muskrats may not be killed by shooting February 15 to April 15); black bear, October 15 to March 1 (unlawful to take bear in steel trap); fisher, marten, and raccoon, October 15 to March 1 (1917, ch. 413).

Propagation.—Permits to breed or domesticate mink, muskrat, skunk, and raccoon are issued by the State game and fish commission; fee, 1 cent for each animal in possession. Also bond ($500) is required as guarantee that no wild animals will be captured during close season for other than breeding purposes. Persons having in lawful possession such fur-bearing animals have a property right therein, and it is unlawful for others to enter inclosures where the animals are confined, or molest them, under such penalties as would result were they ordinary domestic live stock (1913, ch. 32, sec. 4797).

Bounties.—No State appropriation for 1917–18. County or town boards may offer bounty on wolf, gopher, ground squirrel, groundhog, rattlesnake, crow, or blackbird (1909, ch. 48; 1911, ch. 220).

MISSISSIPPI.

Trapping.—No legal restrictions.[1]

Open seasons.—Bear, November 1 to end of February (Code, sec. 2324).

Propagation.—No legal restrictions.

Bounties.—None paid.

MISSOURI.

Trapping.—Wild fur-bearing animals may be destroyed at any time and in any way to protect premises from their depredations (Rev. Stat. 1909, sec. 6521a). Unlawful to sell or offer for sale pelts of fur animals taken out of season (1913, p. 348). Written permission required to trap on lands of another (1913, p. 224). Use of poison prohibited in taking any protected animal (1915, H. B. 605).

Open seasons.—All fur animals, December 1 to February 1 (sec. 6521a as amended, 1917).

Propagation.—Permits to capture for propagating purposes may be obtained from the State game and fish commissioner.

Bounties.—Adult wolf or coyote, $6; young wolf or young coyote, $3; paid by county and one-half refunded by State (sec. 10586).

MONTANA.

Trapping.—License (fee, $1.50) required for trapping, except for wolves, coyotes, and mountain lions. Special license (fee, $10) required for trapping beavers, and permit required to sell beaver skins. Special license (fee, $5) required for trapping on State game preserves. Unlawful to chase bear with dog or dogs (1917, ch. 173).

Open season.—No close season for fur animals, except beaver. Beavers may be taken only under a license; but under special conditions a permit may be obtained to kill beavers that are destroying property; proceeds of sale of pelts so taken to be placed to the credit of the State game fund (1917, ch. 173).

Propagation.—No legal restrictions.

Bounties.—Grown wolf, $15; wolf pup, coyote, or coyote pup, $2.50; mountain lion, $10; paid from State bounty fund raised by tax on live stock (1917, ch. 59).

[1] The act for protection of game and fur animals (1916, ch. 99) was defeated by referendum vote.

NEBRASKA.

Trapping.—Unlawful to trap on premises of another without consent of owner (Code, sec. 2668).

Open seasons.—Muskrat, mink, raccoon, opossum, and otter (on premises of another), November 1 to February 15 (1917, ch. 54). Unlawful to destroy muskrat houses on premises of another. Beaver, no open season, but if the animals are damaging property a permit to destroy them may be obtained from the State game and fish commission (Code, sec. 2668). No close season for other fur animals; any except beavers may be taken at any time on one's own premises.

Propagation.—No legal restrictions.

Bounties.—Such counties as have at any general election voted to pay bounties, pay for wolf, $3; wildcat or coyote, $1; mountain lion, $3 (R. S., 1913, secs. 478–484).

NEVADA.

Trapping.—No legal restrictions.

Open seasons.—No close season except on beavers, which may not be taken until January 1, 1920 (1917, ch. 239).

Propagation.—License (fee, $10, paid annually to county) required from those who wish to propagate game or fur animals (except beaver). Animals on breeder's own lands may be taken at any time for propagation, and those held in captivity by holder of license may be sold at any time. No bounty may be collected on noxious species raised in captivity (1915, ch. 256).

Bounties.—Mountain lion, $5; lynx or wildcat, $2; paid by county (1917, ch. 66). Counties pay bounty of 1½ cents each for pocket gophers when at least 100 heads are presented at one time (1893, ch. 20).

The State board of live stock commissioners is authorized to pay bounty from funds derived from tax on horses, cattle, and hogs. The rewards are, for coyote, coyote pup, wildcat, or lynx, 75 cents each; mountain lion, $5 (1915, ch. 268).[1]

The State board of sheep commissioners is authorized to pay bounty from funds derived from tax on sheep, the payments being the same as those made by the board of live stock commissioners (1915, ch. 247).[1]

NEW HAMPSHIRE.

Trapping.—Fur-bearing animals defined as beaver, otter, marten, sable, mink, raccoon, fisher, fox, skunk, and muskrat. The right of any one to kill predatory fur animals at any time when destroying domestic animals or fowls is granted. Skins legally taken may be bought or sold at any time. No person may destroy a muskrat house or set a trap therein, thereon, or at the entrance thereof. No person may trap upon lands of which he is not owner or lessee. All traps must be legibly marked or stamped with trapper's name, and must be visited at least once in 24 hours. It is an offense punishable by a fine to take traps of another or remove fur animals from them. Unlawful to use spring gun, snare, or poison in taking fur animals. Bear traps must be safeguarded in a substantial manner. License for trapping, except on private lands, is required; fee, resident, $1; nonresident, $15 (1915, ch. 133). Trappers are liable for any damage to domestic animals by traps (1917, ch. 184).

Open seasons.—All fur-bearing animals, except beaver, November 1 to February 28 (29). No open season for beaver. Raccoons and foxes may be taken by use of dog and gun during October (1915, ch. 133).

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[1] No bounties have been paid under the provisions of ch. 247 and 268.

Propagation.—Permit (fee, $2) required to propagate fur animals, game, or fish (1917, ch. 184).

Bounties.—Bear, $5 (1895, ch. 121); hedgehog, 20 cents (1911, ch. 93); wild cat, $2 (1915, ch. 133); paid by State.

NEW JERSEY.

Trapping.—Skunks, minks, muskrats, and otters may not be taken in close season, except that muskrats may be destroyed by owner of canal or dam which they are destroying. Muskrats may be taken by trap only, except in Salem County, above Mill Creek, where they may be taken in open season by firearms and light. It is unlawful to disturb the lodge or nesting chamber of muskrats, to molest traps set by another, or to appropriate or take animals caught in such traps (1913, ch. 126, 161).

Open seasons.—Skunk, mink, muskrat, and otter, November 15 to April 1 (1913, ch. 126); raccoon, October 1 to December 15 (1915, ch. 216). Beaver, unlawful to trap, take, kill, or have in possession at any time (1903, ch. 264). The board of fish and game commissioners may grant permits to hunt foxes with hound and firearms from the last day of the open season for game (December 15) to March 31 (1913, ch. 157).

Propagation.—No restrictions except those imposed by close seasons, during which wild animals may not be taken for breeding purposes.

Bounties.—Fox, $3; paid by only a few counties (1902, ch. 112, amended by 1906, ch. 320).

NEW MEXICO.

Trapping.—No legal restrictions.

Open seasons.—No close season for fur animals, except beavers, which are protected at all times.

Propagation.—No restriction other than that respecting the capture of beavers.

Bounties.—Coyote, wildcat, or lynx, $2; wolf, $15; panther or mountain lion, $10; paid from county wild-animal fund, raised by tax on property (1909, ch. 104).

NEW YORK.

Trapping.—License required for hunting or trapping; fee, resident, $1.10; nonresident, $10. Muskrat houses may not be molested, injured, or disturbed, nor the animals shot at any time. Skunks may not be taken by digging or driving them from dens by chemicals; if injuring property, they may be taken at any time and in any manner (1917, ch. 486). Unlawful to set traps during close season (1917, ch. 170).

Open seasons.—Mink, sable, and raccoon, November 10 to March 15 (raccoon may be taken otherwise than by trapping, October 6 to March 15) (1917, ch. 374); skunk, November 10 to February 10; muskrat, November 10 to April 20. No open season for beaver (1914, ch. 92).

Propagation.—All protected fur animals may be kept alive in captivity for propagation and sale, provided a license be obtained from the conservation commission (fee, $5). No fur-bearing animals may be kept which are taken wild during close season for such animals, nor may they be disposed of during close season (1914, ch. 92).

Bounties.—Panther, $20, paid by State; none paid since May, 1884.

NORTH CAROLINA.

Trapping.—Otters, muskrats, or minks may not be trapped nor their skins sold by anyone who has not resided in the State at least two years (1905, ch. 394).

Open seasons.—Open seasons for hunting and trapping are fixed by local laws; more than half of the 100 counties have local laws relating to fur animals.

Propagation.—No legal restrictions.

Bounties.—None now paid by the State.

Local trapping regulations.—The following local regulations are in force (October, 1917): [1]

Alamance County.—Opossum, open season, October 1 to January 31 (sec. 1883); fox, same open season. Unlawful to carry fox out of State in close season (1911, ch. 654). A misdemeanor to take foxes save only with dogs or dog (1909, ch. 616).

Anson County.—Fox, open season, August 1 to March 31 (1911, ch. 621).

Ashe County.—All fur animals, open season, November 1 to January 31 (1913, ch. 560).

Bertie County.—Opossum and raccoon, open season, October 1 to January 31 (1915, ch. 555). Written permission required to trap on lands of another (1917, ch. 57).

Bladen County.—Opossum and raccoon, open season, October 31 to January 30 (1911, ch. 123). Setting traps in Colly Township regulated (1909, ch. 436).

Buncombe County.—Unlawful to trap on lands of another (1913, ch. 560).

Burke County.—Fox, close season in that part of the county lying south of Catawba River and Cleveland, March 1 to November 30, except when the animals are committing depredations (1907, ch. 388).

Caswell County.—Opossum, open season, October 1 to January 31 (sec. 1883).

Chatham County.—Opossum, open season, October 1 to January 31 (1911, ch. 756); fox, open season, September 1 to January 31 (1911, ch. 135).

Cherokee County.—Unlawful to hunt (except for foxes and wolves) on lands of another without written permission of owner or agent (1907, ch. 452).

Clay County.—All fur animals, open season, November 15 to February 14 (1917, ch. 395). Unlawful to set trap so as to catch live stock (1917, ch. 565).

Columbus County.—All fur animals, open season, January 1 to March 31, except in Bug Hill and Lee Townships, December 1 to February 28 (29). Steel traps of a spread of 14 inches or more may be used at any time provided notice of their setting is posted (1909, ch. 417). Permission required to trap on lands of another (1917, ch. 394).

Craven County.—Otter, mink, muskrat, raccoon, and skunk, open season, December 1 to March 31. Owner of property may kill at any time to protect such property (1915, ch. 37).

Cumberland County.—A bounty of $5 is paid for each bear killed in Cedar Creek and Beaver Dam Townships (1905, ch. 176).

Currituck County.—Otter, raccoon, opossum, mink, and muskrat, open season, November 1 to March 31 (1913, ch. 560). Unlawful to shoot otter or muskrat in open season after sunset or before sunrise on east side of Currituck Sound (1909, ch. 537).

Duplin County.—Fox, open season, September 15 to February 14 (1911, ch. 407).

Durham County.—Opossum, open season, October 1 to January 31 (sec. 1883).

Edgecombe County.—Opossum, open season, October 1 to December 31 (1911, ch. 189).

Forsyth County.—Opossum, open season, October 1 to January 31 (1913, ch. 560).

Franklin County.—Opossum, open season, October 1 to January 31 (sec. 1883); fox, October 15 to February 28(29) (1913, ex. sess., No. 169).

Gates County.—All fur animals, open season, November 15 to March 31 (1911, ch. 745).

Graham County.—Opossum, open season, October 1 to January 31 (sec. 1883).

Granville County.—Fox (with gun or dog), open season, October 31 to February 1 (1917, ch. 598).

Green County.—Opossum, open season, October 1 to January 31 (1907, ch. 598).

Guilford County.—Opossum, open season, October 1 to January 31 (sec. 1883).

Halifax County.—Raccoon and opossum, open season, November 15 to March 1; fox, September 15 to February 28 (29). Unlawful to trap on lands of another without permission (1913, ch. 591).

Harnett County.—Opossum, open season, October 1 to December 31 (sec. 1883).

Haywood County.—All fur animals (except bear), open season, November 15 to January 14. No close season on bear, and fur animals may be destroyed at any time when preying on poultry, pigs, or lambs (1913, ch. 366).

Henderson County.—Fur animals, except wildcat, opossum, and mole, are protected by a close season from March 15 to November 14 (1913, ch. 560). The board of county

[1] The references are to public local laws of various years or to sections of Pell's Revisal of 1908, ch. 40.

commissioners are authorized to add to the list of protected fur bearers, and fix the open season for killing them (1915, ch. 677). Trapping on lands of another without permission of owner or agent is unlawful (1915, ch. 135).

Hoke County.—Unlawful to hunt or trap on lands of another without permission. Nonresidents require license (fee, $15, unless for hunting or trapping deer, wild turkeys, or foxes, when the fee is $25) (1915, ch. 459).

Iredell County.—Opossum, open season, October 1 to February 28 (29) (1917, ch. 459).

Johnston County.—Opossum, open season, in Bentonville, Boone Hill, and Wilder Townships, November 1 to February 28 (29) (1913, ch. 648).

Lee County.—Fox, open season, October 1 to February 28 (29); unlawful to carry out of State in close season (1911, ch. 291).

Lenoir County.—Fox, open season, September 15 to February 14 (1917, ch. 673).

Lincoln County.—Opossum, open season, October 1 to December 31 (sec. 1883); fox, November 15 to January 31, except that when doing damage to fowls or other live stock, foxes may be killed at any time (1913, ch. 359).

McDowell County.—Opossum and raccoon, open season, October 15 to February 28 (29) (1913, ch. 70).

Macon County.—All fur animals, open season, November 15 to February 14 (1917, ch. 395).

Mecklenburg County.—Opossum, open season, October 1 to January 31; fox, November 15 to January 31. Foxes may be killed at any time if destroying property of value (1911, ch. 543).

Mitchell County.—Raccoon, October 15 to January 31 (1913, ch. 369). Bounty of 50 cents each on weasel, mink, and horned owl (1913, ex. sess., No. 99).

Montgomery County.—Opossum, open season, October 1 to December 31 (1911, ch. 102); fox, October 15 to January 14 (1911, ch. 291).

Moore County.—Opossum, open season, October 1 to January 31 (sec. 1883); fox, October 1 to February 28 (29) (1911, ch. 291); unlawful to carry fox out of State in close season.

New Hanover County.—Fox, open season, September 15 to February 14 (1917, ch. 673).

Onslow County.—Fox, open season, September 15 to February 14 (1917, ch. 673).

Orange County.—Opossum, open season, October 1 to January 31 (sec. 1883).

Pamlico County.—Opossum, open season, October 1 to January 31 (sec. 1883).

Pasquotank County.—Raccoon, opossum, mink, muskrat, wildcat, and bear, open season, November 1 to March 31 (1913, ch. 369).

Pender County.—Fox, open season, September 15 to February 14 (1911, ch. 407).

Polk County.—Opossum, open season, October 1 to January 31 (1915, ch. 454).

Randolph County.—Opossum, open season, October 1 to December 31 (1911, ch. 24).

Richmond County.—Raccoon, open season, September 1 to March 31 (sec. 1883a); fox, October 1 to February 28 (29) (may be taken only with dogs) (1913, ch. 520).

Robeson County.—Otter, skunk, raccoon, mink, muskrat, and opossum, open season, October 1 to February 28 (29). Hunting license required to take except on one's own premises. Snares and traps unlawful (1917, ch. 537).

Rockingham County.—Opossum, open season, October 1 to January 31; may be destroyed at any time by landlord or renter to protect crops (1911, ch. 756). Unlawful to shoot or trap fox (1905, ch. 752).

Rutherford County.—Fox, open season (in three townships—Golden Valley, Logans Store, and Duncans Creek), November 1 to January 31; to be hunted with dogs only (1913, ch. 591). No close season in other townships.

Sampson County.—Fox, open season, September 15 to February 14 (1917, ch. 673). Opossum, open season, October 1 to February 28 (29) (1911, ch. 19).

Scotland County.—Open season for fox, August 15 to February 28 (29). Nonresident requires license (fee, $0.25) to hunt foxes (1917, ch. 57). Permission required to trap on lands of another.

Stokes County.—All fur animals, open season, September 1 to January 14 (1917, ch. 588).

Surry County.—Opossum, open season, October 1 to December 31 (1915, ch. 289).

Swain County.—Mink, otter, muskrat, skunk, raccoon, and opossum, open season, November 15 to February 14; owner of property may kill at any time to protect it (1915 ch. 772).

Vance County.—Fox, raccoon, opossum, open season, November 15 to February 28 (29); but may be run down and caught by dogs at any time (1913, ch. 718).

Wake County.—Raccoon and opossum, open season, October 1 to January 31 (1913, ch. 225).

Warren County.—Fox, no close season (1913, ch. 560).

Watauga County.—All fur animals (except mink and muskrat), open season, November 1 to March 14. They may be taken in open season only with dogs and gun or either. Mink and muskrat not protected (1913, ch. 533).

Wayne County.—Fox, open season, September 15 to February 28 (29) (1917, ch. 673).

Wilkes County.—Opossum, open season, October 15 to February 28 (29) (at night); but may be shot at any time when killing fowls or pigs. Fox, open season, October 1 to February 14, except that they may be killed in close season when destroying fowls; may not be shot at any time except to protect property (1913, ch. 77).

Yadkin County.—Opossum, open season, October 1 to February 28 (29) (1911, ch. 71).

NORTH DAKOTA.

Trapping.—A license is required to trap except on one's own lands; fee, resident, $1; nonresident, $25. The protected fur animals are mink, muskrat, otter, and beaver; but minks and muskrats may be killed at any time by owner of property destroyed by them. Muskrat houses are protected at all times (1915, H. B. 300).

Open seasons.—Mink and muskrat, November 16 to April 14; beaver and otter, January 10 to March 10. Only licensed trapper may take beaver, but not upon posted lands. Possession of green hides of mink or muskrat illegal after April 19 (1917, S. B. 74).

Propagation.—The State game and fish board issues permits to breed and domesticate protected birds and animals and also permits to ship them when raised in captivity. Annual reports are required of licensed breeders (1915, H. B. 300).

Bounties.—Wolf or coyote (killed within State), $2.50 each; paid from fund raised by direct taxation on all property (1903, ch. 207).

OHIO.

Trapping.—Written permission required to hunt or trap on lands of another (1917, H. B. 115). The close season for certain fur animals does not prohibit owners or tenants of land from destroying them to protect property. Digging out skunk dens or smoking the animals therefrom is unlawful, as is also the possession of green skunk pelts in close season (1913, H. B. 80).

Open seasons.—Raccoon, muskrat, mink, skunk, and opossum, November 15 to February 1; fox, October 2 to January 9. Protected animals may be destroyed by owner of premises (except on Sunday) when damaging property (1917, H. B. 109).

Propagation.—No restrictions, except those which prevent capture of wild stock in close season.

Bounties.—Townships pay a bounty of $1 each on certain hawks (1915, H. B. 79); 20 cents per dozen on English sparrows; and, under certain conditions, 10 cents each on ground hogs (P. & A. Code, 1912, secs. 5824–5827).

OKLAHOMA.

Trapping.—Unlawful to sell pelts of fur animals taken between March 1 and November 1 (1917, H. B. 542).

Open seasons.—No open season for otter or beaver. Other fur animals, November 1 to March 1 (1917, H. B. 542). No open season for bear in Comanche, Caddo, Kiowa, Major, and Blaine Counties (1915, ch. 258).

Propagation.—The State game warden issues permits to propagate fur-bearing animals, game, and fish; cost $2, together with fees for tagging. Licensed breeders may sell and transport animals raised in preserves under rules prescribed by the warden (1915, ch. 185.)

Bounties.—County commissioners are authorized to offer bounty on gray wolf ($3) and coyote ($1) (1890, S. B. 458). Bounties on hawks, crows, etc., paid by counties (not to exceed $200 a year in any county) are refunded to county from State game fund (1917, H. B. 542).

OREGON.

Trapping.—License (fee, $1.50) is required of all persons over 16 years of age to trap on lands not their own. No flesh of game animal or bird may be used to bait traps. Unlawful to remove or disturb traps of a licensed trapper on public domain or on lands where he has permission to trap. Licensed trappers are required to make annual reports of number of animals caught and receipts for fur sold. If beavers or other fur animals damage property, permits to kill them may be obtained from the State board of fish and game commissioners. Skins of such animals are the property of the State, to be sold and the proceeds used in paying for damage to property. Unlawful to destroy muskrat house, except where it obstructs ditch or watercourse (1913, ch. 282).

Open seasons.—Mink, otter, fisher, marten, and muskrat, November 1 to February 28, inclusive. No open season for beaver, except in Benton and Marion Counties, where no close season is provided (1917, ch. 340). No open season for fur animals on State game preserve (1913, ch. 232).

Propagation.—Permits (fee, $2) to keep fur-bearing animals may be obtained from the State board. No wild fur animals may be taken for propagating purposes in close season nor may those held in captivity under permit be sold in that season. Yearly reports to the State board are required (1913, ch. 232).

Bounties.—Coyote or coyote pup, $3 (bounty on adult female to increase $1 each year); gray or black wolf, $5; wolf pup, $2.50; bobcat, wildcat, or lynx, $2.50; mountain lion, $10; seal or seal pup, $3; paid by county and half refunded by the State (1917, ch. 133). The State board is empowered to pay additional bounties, at its discretion, on any predatory animal in order to protect game (1913, ch. 232); under this act the State board now pays for wolf, $20; for cougar, $15. Several counties are authorized by law to levy a special tax and pay bounties on moles, rabbits, or gophers (1917).

PENNSYLVANIA.

Trapping.—Nonresident trapper requires license (fee, $10) (1917, No. 86). Unlawful to trap bears, and only one may be killed in a season. No steel traps larger than No. 3 size may be used for trapping wildcats or other fur animals. Resident requires no license for trapping, but hunting licenses required for killing raccoons or bears, which are regarded as "game" animals.

Open seasons.—Bear, October 15 to December 15; raccoon, September 1 to December 31. No open season for beaver. Foxes may not be trapped, shot, snared, or poisoned in Delaware County (1915, P. L., 146).

Propagation.—No legal restrictions on raising fur animals, except that possession and breeding of ferrets is unlawful except under license from the State board of game commissioners; fee for license to breed and sell ferrets, $25; to possess a ferret without breeding, $1 (1915, P. L., 146).

Bounties.—Wildcat, $6; fox, $2; mink, $1; weasel, $1; paid from special fund created by setting aside one-half the receipts by the board of game commissioners from gun licenses, fines, etc. (1915, P. L., 126).

PORTO RICO.

Porto Rico has no wild fur animals.

RHODE ISLAND.

Trapping.—Hunting license is required for trapping, except on one's own lands; fee, resident, $1; nonresident, $10; alien, $15; toegther with an additional fee of 15 cents for issuing license. Unlawful to trap on posted lands or on lands of another without written permission. Unlawful to set wire snares, or to use steel traps with teeth or with spread over 6 inches, or choke traps

with greater opening than 6 inches. Traps must be concealed so as not to endanger domestic animals and must be visited at least once in 24 hours.

Open seasons.—Skunk, muskrat, raccoon, and mink, November 1 to April 15 (1916, ch. 1399). Landowners may kill protected animals on their own lands at any time (1915, ch. 1230).

Propagation.—No legal restrictions.

Bounties.—Fox, $3; crow and certain hawks and owls, 25 cents; paid by State.

SOUTH CAROLINA.

Trapping.—Unlawful to hunt or trap on lands of another without his consent. Unlawful at any time to shoot or trap foxes in York, Union, Chesterfield, Edgefield, Lee, Cherokee, Chester, Fairfield, Lancaster, Richland, Abbeville, Calhoun, Sumter, Orangeburg, and Marlboro Counties. Nonresidents (except freeholders) require license (fee, $5) to chase foxes in Chester, York, Cherokee, and Union Counties (C. Code, sec. 740, acts 1916, Nos. 427 and 435).

Open seasons.—Fox in 15 counties (named above), September 1 to February 14 (C. Code, sec. 740, acts 1916, Nos. 427 and 435).

Propagation.—No legal restrictions.

Bounties.—None paid.

SOUTH DAKOTA.

Trapping.—License (fee, $5) required for taking mink, muskrat, otter, or beaver, except on trapper's own lands. Boys under 18 years of age do not require license (1917, ch. 245). Nonresident trapping license, $10 (1909, ch. 183). Skins of fur animals killed out of season may not be bought or sold (1909, ch. 240).

Open seasons.—Mink, muskrat, otter, and beaver, December 1 to March 31 (1917, ch. 245).

Propagation.—No restrictions, except that protected animals may not be taken for breeding purposes in close season.

Bounties.—Counties shall pay $4 for coyote and $8 for wolf, killed within the county (1917, ch. 149).

TENNESSEE.

Trapping.—Owner of land may hunt or trap on such land at any time; others may do so only with the written consent of owner. Steel traps must be placed at least 12 inches within the entrance to a hole, cave, den, or hollow log. Traps and deadfalls must be inspected within each 36 hours, and captured animals removed (1915, ch. 152); does not apply to trapping wildcats in Lauderdale County (1917, ch. 205).

Open seasons.—For trapping fur bearers off one's own land, from noon October 15 to noon January 15 (1915, ch. 152).

Propagation.—No legal restrictions.

Bounties.—Wolf or panther, $2 certificate issued by county court, the amount to be applied on payment of taxes (1889, ch. 200).

Local laws of counties:

Blount and Union Counties.—Unlawful to shoot fox, to trap or injure young foxes, or to destroy their dens (1917, chs. 315, 594).

Carter and Johnson Counties.—Unlawful to trap, shoot, or kill fox or to destroy fox den, except near farm buildings when they destroy fowls or live stock (1915, ch. 593).

Claiborne, Grainger, Davidson, Roane, and Shelby Counties.—Unlawful to set a trap more than 200 yards from trapper's residence (1915, chs. 413, 497; 1917, ch. 724).

Davidson, Robertson, and Shelby Counties.—Open season for beaver, muskrat, fox, mink, raccoon, skunk, and opossum, September 1 to January 31. Sale of these animals or their skins restricted to November 1 to January 31 (1915, ch. 691).

Dyer County.—Open season for raccoon, mink, and otter, October 1 to February 15 (1911, ch. 638).

Meigs and Rhea Counties.—Same provisions about foxes as in Blount and Union Counties, but also sale of the animals or their pelts is prohibited (1917, ch. 656).

Smith County.—Open season for trapping fur animals, October 15 to February 15 (1917, ch. 693).

Warren county.—Open season for opossum, raccoon, and other fur animals, November 1 to February 28 (29) (1917, ch. 256).

TEXAS.

Trapping.—No license required for trapping, but on posted lands consent of owner is necessary (1915, ch. 47).

Open seasons.—No close season for fur animals.

Propagation.—No legal restrictions.

Bounties.—None paid by State.

UTAH.

Trapping.—No license required for trapping. Aliens other than homesteaders are not allowed to hunt or trap in the State (1917, ch. 95).

Open seasons.—Beaver and otter protected at all times. If beavers destroy property, the State fish and game commissioner may give permit to kill, but hides must be delivered to the commissioner to be sold for benefit of game fund (1917, ch. 79). No close season on other fur animals.

Propagation.—No legal restrictions.

Bounties.—Wolf, $50; bear, mountain lion, or cougar, $25; coyote, lynx, or bobcat, $2.50; jack rabbit or pocket gopher, 5 cents; prairie-dog or ground squirrel, 3 cents; paid from State bounty fund, raised by direct appropriation and a tax of 5 mills on live stock (1917, ch. 125).

VERMONT.

Trapping.—License is required for trapping, except on one's own land; fee, resident, 60 cents; nonresident, $10.50. Persons trapping on inclosed lands of another must inform owner of location of traps and must visit traps at least once in 24 hours. The use of spring guns is prohibited, and bear traps must be carefully safeguarded. Skins of fur animals legally taken may be bought or sold at any time. Unlawful to open or destroy a muskrat house or to place a trap at its entrance. Unlawful to dig skunks from dens or to drive them out by use of smoke or chemicals.

Open seasons.—Mink, otter, and muskrat, November 1 to April 30; marten, raccoon, fisher, and skunk, October 20 to March 31; fox, October 20 to April 1 (may be taken otherwise than by trapping at any time). No open season for beaver (1915, ch. 201).

Propagation.—The State fish and game commissioner issues special permits for propagating fur and game animals (fee, $2 and expense of tagging). Animals bred on fur farms may be sold and transported alive at all times when bearing the identification tags prescribed by the commissioner (1915, ch. 231).

Bounties.—Hedgehog (porcupine), 15 cents; paid by State (1912, ch. 207). Towns pay $5 bounty on bay lynx or bobcat (1915, ch. 185).

Local laws:

Addison County.—Open season for muskrat, March 1 to April 30.

Franklin County.—Open seasons: Muskrat, November 1 to April 30; fox, November 1 to February 28 (29); other fur animals, November 1 to March 31 (1917, No. 219).

Shores of Lake Champlain in Rutland County, Poultney River below Carvers Falls, and shores of Lake Memphremagog in Orleans County.—Open season for mink, muskrat, or otter, January 1 to April 30 (1917, No. 218).

VIRGINIA.

Trapping.—The following applies to any county after adoption by the board of supervisors: Trapping for fur animals on lands of another is unlawful except from noon of October 15 to noon of January 15, and then only with

written permission of landowner, which permission the trapper must have on his person when trapping. He must visit traps at least once in 36 hours and is liable for any damage such traps may do to domestic animals. Landowner may trap or kill fur animals on his own lands at any time (1916, ch. 376).

Open seasons.—(Applies to any county adopting the law). All fur animals on lands of another, noon of October 15 to noon of January 15 (1916, ch. 376).

Propagation.—No legal restrictions.

Bounties.—Boards of supervisors of counties may at their discretion pay bounties—not over $10 for wolf; $1.50 for wildcat, catamount, or red fox; and 75 cents for chicken hawk or owl (Code, sec. 834).

Local trapping regulations.—The following provisions are in force:

Culpeper County.—Unlawful in Jefferson magisterial district to trap foxes except in November and December. Traps set for foxes must be visited daily to release any dog that may be caught (1912, ch. 257).

Fauquier and Loudoun Counties.—Unlawful to take foxes April 1 to August 31, except by owner or tenant of land to protect property. Unlawful in open season to shoot, trap, or poison foxes except on written authority of a landowner (1914, ch. 141).

Halifax County.—Opossum, open season, October 15 to January 31 (1892, ch. 40).

Loudoun County.—License (fee, $2.50) required to trap mink, muskrat, skunk, opossum, and raccoon on lands of another. Open season for mink, muskrat, and skunk, November 1 to February 28 (29); for opossum and raccoon, October 1 to February 28 (29) (1916, ch. 23).

Nansemond County.—Mink, otter, and muskrat, open season, January 1 to March 31 (1914, ch. 223).

Patrick County.—Wild raccoon or opossum, open season, October 15 to March 14; gray fox, September 15 to March 14 (1912, ch. 247).

Princess Anne County.—Unlawful to catch, trap, or kill mink, muskrat, or otter for profit, except from November 1 to March 14 (1910, ch. 191).

Rappahannock County.—Unlawful to trap or hunt on lands of another without written permit from owner (1910, ch. 361).

Amherst, Essex, King George, and *Loudoun Counties* are authorized to pay bounty of 50 cents each on certain hawks (1916, chs. 7, 124, 336).

WASHINGTON.

Trapping.—Trapping license (fee, $5) required. No steel trap larger than No. 4 may be used unless a notice in the English language on a large placard is placed above the trap; this requirement does not apply to trapping coyotes, muskrats, minks, skunks, martens, civet cats, and weasels (1917, ch. 164).

Open seasons.—Bear, September 1 to April 30; at any time when found destroying domestic animals (1917, ch. 164). No open season for beaver (R. & B. Code 1910, sec. 5395). No close season for other fur animals.

Propagation.—No legal restrictions.

Bounties.—Mountain lion or cougar, $20; lynx or wildcat, $5; coyote, $1; timber wolf, $15 (1909, ch. 193); seal or sea lion in Columbia River district, $3 (1917, ch. 164); paid by State. Counties are permitted to pay additional rewards for destroying these animals, and also bounties on bear, muskrat, and squirrel (R. & B. Code 1910, secs. 3587–3592).

WEST VIRGINIA.

Trapping.—An owner of lands or his agent or tenant may hunt or kill protected fur animals on such lands at any time, but it is unlawful to set or maintain a snare or trap upon lands of another without express permission of owner or tenant. Unlawful to set a steel or spring bear trap on lands of another. Hunting license is required for trapping; fee, resident, $3; nonresident, $16.

Open seasons.—Red fox, raccoon, mink, and skunk, November 1 to December 31 (1915, ch. 14). Any county may by majority vote provide a perpetual close season on skunk (1903, ch. 44).

Propagation.—No restriction on possession or sale, but animals may not be taken for breeding purposes in close season except on lands owned or tenanted by the breeder.

Bounties.—Wildcat, bobcat, or catamount, $5; crow, 10 cents; certain hawks and owls, 25 cents; paid from forest, game, and fish protection fund (1915, ch. 14).

WISCONSIN.

Trapping.—License required for trapping; fee, resident, $1; nonresident, $25; report required from licensed trapper. Unlawful to take fisher, marten, mink, or muskrat with the aid of spear, gun, or dog; to take rabbit with ferret; to disturb or molest muskrat houses, or beaver houses or beaver dams, or raccoon den trees for the purpose of capturing raccoons; or to set traps within 500 feet of any beaver dam or beaver house. Steel traps may be used for taking fur animals in open season. The possession of green skins of any fur-bearing animal during close season is unlawful, as is also the possession at any time of the skin of a fisher, marten, mink, or muskrat which shows that the animal had been shot or speared.

Owners of cranberry marshes may at any time destroy muskrats to protect dams, but they may not sell, barter, or give away the skins of such animals killed during close season.

Beavers and otters are protected at all times except beavers in 3 counties. If beavers damage property, they may be captured and removed under the direction of the State conservation commission (1917, ch. 668).

Open seasons.—Beaver in Price, Rusk, and Sawyer Counties, December 1 to December 31 (1917, 1918); black bear, November 10 to December 1; fisher, marten, mink, and skunk, November 15 to February 1; raccoon, October 15 to January 1 (bag limit 5 a day); muskrat, (18 counties) October 15 to April 20, (53 counties) October 15 to April 10 (1917, ch. 668).

Propagation.—Breeders of protected game or fur animals must obtain a license from the State conservation commission (fee, $5) and make annual reports to the commission. The commission will furnish tags at cost of same to enable breeders to ship, sell, and transport animals or skins from their establishments (1917, ch. 668).

Bounties.—Wolf cub taken between March 1 and November 1, $4; mature wolf killed at any time, $10; fox, $2; paid by county. County boards may increase these rewards, but no county may pay more than $6 for killing a wolf cub. The State treasurer duplicates all county awards, thus doubling the above bounties. Poisons may be used for destroying animals for bounty between December 1 and March 1, but notice of putting out baits must be posted, and they may not be placed within 80 rods of a dwelling house (1917, ch. 676). County boards may offer bounty on crow, hen hawk, pocket gopher, streaked gopher, English sparrow, blackbird, or rattlesnake (1913, ch. 773).

WYOMING.

Trapping.—Unlawful to trap game animals or birds or to use their flesh as trap bait for predatory animals. Unlawful to trap on State game preserves without permit (fee, $5) (1915, ch. 91), and for anyone not employed by the United States Department of Agriculture to trap in national forests within the State without first obtaining a permit (fee, $5) from the State game warden (C. S. 1910, Mullen, sec. 2786). Nonresident of State must secure a special license (fee, $10) to hunt, pursue, trap, or kill bears (sec. 2748).

Open seasons.—No close season on fur-bearing animals except beavers, which may not be taken at any time until September 15, 1919, but if they damage real estate the owner may obtain permit to destroy them (sec. 2769).

Propagation.—No legal restrictions.

Bounties.—Coyote, $1.50; bobcat, $1; adult gray or black wolf, $15; gray or black wolf pup, $10; mountain lion, $5, paid from State appropriations (1917, ch. 85).

ALBERTA.

[From "Game act," as amended to 1917.]

Trapping.—Nonresident requires license to trap; fee, $25. Unlawful to use poison for taking fur-bearing animals; to destroy, partially destroy, or leave open any muskrat or beaver house; or to destroy a beaver dam, unless authorized to do so by the lieutenant governor in council, who may also authorize the killing of beavers or other fur animals when such killing is deemed to be in the public interest. Export of unprime skins or pelts is forbidden, unless by permit from the minister of agriculture. No fox may be trapped or taken alive for export. Every company, firm, or person engaged in the fur trade must make annual returns of the number of skins bought or sold (game act, 1915).

Open seasons.—Mink, fisher, and marten, November 1 to March 31; otter and muskrat, November 1 to April 30. No open season for beaver until December 31, 1920, unless locally by order of the lieutenant governor in council (game act, 1915).

Propagation.—Manager of fur farm required to make reports January 1 and July 1 of each year. Export of live animals from fur farms allowed only on permit from the minister of agriculture. Permit, with fees, required to export live muskrats, minks, fishers, martens, otters, or beavers whether raised on a fur farm or otherwise (orders in council).

Bounties.—The council of any rural municipality is authorized to offer a bounty on wolves.

BRITISH COLUMBIA.

Trapping.—License required to trap off one's own lands; fee, resident, $10; nonresident, $100. A licensed trapper who first occupies a trap line prior to November 14 is protected against other trappers. License must be returned within two months after it expires with a statement of number of fur animals of each kind taken. It is unlawful to touch or interfere with traps set by a licensed trapper, to trap on inclosed or cultivated land without permission of owner, or to permit traps to remain set after close of season. Export of pelts is allowed only during open season and for 60 days thereafter (1914, ch. 33). Special license (fee, $25) is required by nonresident to hunt bears.

Open seasons.—Fox, November 1 to March 16; all other fur animals (beaver, marten, fisher, mink, muskrat, otter, raccoon, and weasel, or ermine), November 1 to April 30 (orders in council, August 4, 1917).

Propagation.—A permit to propagate fur-bearing animals is required. Breeder must keep a record of transactions as to purchases and sales of stock, which record must be open to inspection of any game warden (1914, ch. 33). Live foxes may be exported only under permit; fee, $100. Special license is required to take foxes or other fur animals in close season.

Bounties.—Rates fixed from time to time by lieutenant governor in council.

MANITOBA.

[From "Game protection act," as amended to 1917.]

Trapping.—A license is required to trap, except on one's own land; fee, resident, 50 cents; nonresident Canadian citizen, $25; nonresident alien, $100. Report giving number of animals of each kind taken under license is required

to be made between June 1 and July 1. Persons trading in furs must be licensed (fee, resident, $5; nonresident, $50) and are required to make annual returns before August 1. Unlawful to trap in Provincial game preserves, to trap on cultivated or inclosed lands without permission of owner, to destroy a muskrat or beaver house, to use poison in taking fur animals, or to export unprime skins. Poison may not be used to capture wolves for bounty.

Open seasons.—South of fifty-third parallel: Fisher, pekan, sable, marten, and mink, November 1 to March 31; otter and beaver, no open season; fox and lynx, no close season. *North of fifty-third parallel:* Fisher, pekan, sable, marten, and mink, November 1 to March 31; otter and beaver, November 1 to April 30; fox and lynx, November 1 to February 28 (29).

Muskrat, *south of fifty-first parallel:* March 1 to May 14; *north of fifty-first parallel:* October 20 to November 30, and March 1 to May 14. Unlawful to shoot or spear muskrats.

Propagation.—No legal restrictions except that a special permit must be obtained to export live fur animals; fee, for black or silver fox, $100; for other fox, $15; for live otter, $25; for any other fur animal, $5.

Bounties.—Timber wolf, $5; other wolf, $2; half is refunded to municipality by the Provincial treasurer (1915, ch. 95).

NEW BRUNSWICK.

[From "Game act of 1909," as amended to 1917.]

Trapping.—Nonresidents require a license (fee, $25) for trapping. A license is also required to deal in, buy, sell, cure, or tan the skins of fur-bearing animals. The digging out of foxes from their homes or earth burrows is prohibited at all times. Unlawful to possess green skins or carcasses of protected fur animals in close season.

Open seasons.—Mink, otter, and fisher, November 1 to March 31; fox, October 1 to February 28 (29); muskrat, noon of March 25 to noon of May 15. Beaver and sable, close season to July 1, 1919. The surveyor general, when satisfied that a number of beavers may be taken from any stream without injury to the supply, may issue a special license for taking them; fee, $2 for each animal taken.

Propagation.—Permits to capture wild fur-bearing animals for propagation within the Province may be obtained from the surveyor general, who fixes the fee for such permit.

Bounties.—Wildcat (killed within the Province), $1, paid by the surveyor general.

NEWFOUNDLAND.

[From game laws of Newfoundland, 1913, corrected to 1915.]

Trapping.—Nonresident trappers require annual license; fee, $501. Fur buyers and shippers also require annual license (fee, 50 cents), and must report operations under same before December 31 of each year. Trapping on Grand Lake Caribou Preserve is unlawful at all times.

Open seasons.—Otter, marten, and lynx, October 1 to March 31; fox, October 15 to March 14; muskrat, October 1 to April 30. No open season for beaver until October 1, 1918.

Propagation.—No restrictions, except as to foxes. A fox farm must be licensed; the owner must at stated times make reports to the game and inland fisheries board, and the premises must be at all times open to inspection by

officers of the board. Possession of fox cub or fox taken in close season is prohibited. Unlawful to export a fox not bred on a fox farm, or, without permit from the colonial board, to export a fox bred in captivity.

Bounties.—None paid.

NORTHWEST TERRITORIES.

Trapping.—Use of poison prohibited in taking fur-bearing animals. Export of low-grade furs forbidden (1903, 2d sess., ch. 29).

Open seasons.—Mink, fisher, and marten, November 1 to May 14; otter, beaver, and muskrat, October 1 to May 14.

Propagation.—No legal restrictions.

Bounties.—None paid.

NOVA SCOTIA.

Trapping.—Nonresident requires a license (fee, $30) to take fur-bearing animals, which are included in the term "game." Unlawful to take any protected fur animal (unless under a permit) from a burrow or den by smoking or digging; to take fur animal by use of poison; to damage or molest a beaver dam or house, or a muskrat house, or set snare or trap within 25 feet of the latter; or to have in possession the green hide or pelt of a fur animal taken out of season (1915, ch. 38).

Open seasons.—No open season for beaver or marten. Mink, otter, fox, raccoon, muskrat, and all other fur-bearing animals (except bear, wolf, and wildcat, which are not protected), November 1 to January 31 (1915, ch. 38).

Propagation.—Permits to take wild animals may be obtained from the board of game commissioners under such restrictions as they may require. Unlawful to keep fur-bearing animals in captivity for breeding purposes without a permit from the chief game commissioner; fee $2 for each kind of animal kept, payable annually. Reports are required annually on September 30. Inclosures for fur animals are protected from trespass (1912, ch. 59).

Bounties.—None paid.

ONTARIO.

[From Rev. Stat., ch. 262, as amended to 1917.]

Trapping.—License to trap required except to take wolf and fox or to trap on one's own land; fee, resident, $5; nonresident, $50. License (fee, $2) is required of all fur dealers or traders. Dealers may obtain a permit to hold furs during close season. Muskrats may not be shot or speared at any time. Muskrat houses are protected at all times except when the animals are injuring property. Beavers, when damaging property, may be destroyed by game overseer under special authorization from the superintendent of game fisheries.

Open seasons.—Mink, November 1 to April 30; muskrat, north of French and Mattawa Rivers, April 1 to May 20; south of said rivers, March 1 to April 20; beaver and otter, protected to November 1, 1916, since which date hunting, taking, or killing them permitted only during such periods and on such terms and conditions as may be prescribed by the lieutenant governor in council (1915, ch. 20).

Propagation.—A permit is required of breeders of game or fur animals. Licensed fur breeders may sell live animals or skins at any time. The minister may grant permits to take fur animals during the close season for propagating and scientific purposes.

Bounties.—Gray timber wolf, $15; other wolf, $5; paid by county, but Provincial treasurer refunds 40 per cent to county. Provincial treasurer pays entire bounty in unorganized counties (1916 wolf bounty act).

PRINCE EDWARD ISLAND.

Trapping.—Nonresident requires license (fee, $50) for trapping. Unlawful to put out poisoned baits for foxes or other animals.

Open seasons.—Marten, mink, muskrat, and otter, November 1 to March 31; beaver, no open season, and the animals or their pelts taken in the Province may not be sold (1917, ch. 11).

Propagation.—Several special acts of the Provincial legislature regulate fox ranching on the island. The animals are assessed for taxation (1913, ch. 9); ranches are protected from trespass, under heavy penalties (1913, ch. 10); and incomes from ranches are taxed (1917, ch. 3).

Bounties.—None paid.

QUEBEC.

[From Rev. Stat., 1909, ch. 8, as amended to 1917.]

Trapping.—Reports are required of all persons engaged in the fur trade (buying, selling, or taking fur animals) before September 1 of each year.

Open seasons.—Zone No. 1 (west and south of Saguenay River): Mink, otter, marten, pekan (fisher), fox, and raccoon, November 1 to March 31; bear, August 20 to June 30; muskrat, during April only. Beaver, protected to November 1, 1917; open season thereafter, November 1 to March 31. *Zone No. 2* (east and north of Saguenay River); Mink, marten, and pekan, November 1 to March 31; bear, August 20 to June 30; muskrat, November 1 to March 31; otter, October 15 to April 14; beaver, November 1 to March 31.

Propagation.—The minister of colonization, mines, and fisheries may grant permits to take animals alive for breeding purposes; nonresidents are charged a fee of from $5 to $25 for such license.

Bounties.—Wolf, $15.

SASKATCHEWAN.

[From Rev. Stat., 1909, as amended to 1917.[

Trapping.—Nonresident requires license (fee, $25) to trap. Unlawful to trap on game refuges; to use poison for taking fur animals; to spear or shoot muskrats, or to destroy muskrat house or beaver dam; to export unprime furs; to buy or sell furs without license (fees, residents north of township 25, $10; south of township 26, $2; nonresidents, $25); and to ship any fur animal in concealed receptacle. Licensed fur traders must make annual report of operations.

Open seasons.—Mink, fisher, and marten, November 1 to March 31; otter and muskrat, November 1 to April 30; fox, north of township 50, November 1 to March 31; beaver, north of Churchill River, November 1 to April 30; no open season for beaver south of Churchill River until December 1, 1920 (1916, ch. 30).

Propagation.—Permit required (fee, $1 annually) to operate a fur ranch. Permit to ship live fur animals is required; fee, for black or silver fox, $25; for cross or red fox, $5; for other fur animal, $5. Young foxes may not be taken from dens before May 15.

Bounties.—Timber wolf, $5 (pup, $1); prairie wolf, or coyote, $1; paid only in properly gazetted wolf districts, when half is refunded from Provincial treasury (1907, ch. 28).

YUKON.

Trapping.—Use of poison in taking animals forbidden.

Open seasons.—No close season except for young foxes; these may not be taken from April 1 to May 31.

Propagation.—No restrictions other than as to foxes. Registration of fox breeders required. Unlawful to export a fox not born in captivity or which has been in captivity for less than a year; any fox born in captivity may be exported under a permit (fee, $5). Fox and other fur ranches, if posted against trespass, may not be approached without owner's consent.

Bounties.—None paid.

SUMMARY OF FUR PROTECTION.

Beaver.—No open season in 22 States, Alaska, 6 Canadian Provinces, and parts of 2 others; close season in 10 States, 3 Provinces, and parts of 2 Provinces; may be taken under special license in Michigan, Montana, and New Brunswick; not protected in 16 States and Yukon, the majority of which have no beavers within their borders.

Otter.—No open season in 8 States, Ontario, and part of Manitoba; close season in 19 States and certain counties of 3 others; Alaska, 9 Provinces, and part of Manitoba; not protected in 18 States.

Muskrat.—Close season in Alaska, 24 States, certain counties of 3 States, and all of Canada except Yukon; no close season in 20 States and Yukon; muskrat houses and dens are protected in 14 States and 5 Provinces.

Mink.—Close season in 27 States, Alaska, certain counties of 3 States, and nearly all of Canada; no close season in 18 States and Yukon; bounty in Pennsylvania.

Marten.—No open season in Alaska, New Brunswick, and Nova Scotia; close season in 8 States and 8 Provinces.

Fisher.—Close season in 7 States and 8 Provinces.

Skunk.—Close season in 22 States and a few counties of 2 others and in Nova Scotia.

Raccoon.—Close season in 22 States, certain counties of 3 States, and in British Columbia, Nova Scotia, and part of Quebec.

Opossum.—Close season in 13 States and certain counties of 3 others.

Fox.—Close season in Alaska, 13 States, certain counties of 4 States, and in 6 Provinces; bounties paid in 4 States and in certain counties of 4 others.

Lynx and wildcat.—Close season in Alaska and Manitoba; not usually protected; bounties paid in 17 States and a few counties of 3 or 4 others. New Brunswick pays bounty on wildcat but not on lynx.

Bear.—Close season in 8 States and (for brown bear) in Alaska; no open season in 5 counties of Oklahoma; open season in British Columbia, dependent on orders in council; bounty on bears paid in 4 States and a few counties elsewhere; special enactments forbidding trapping, or regulating it, exist in several States.

Weasel.—Close season in Alaska and British Columbia; State bounty paid in Pennsylvania and town bounty permitted in Connecticut.

Ferret.—The black-footed native ferret is an exceedingly useful animal, not widely distributed and not legally protected. Domesticated ferrets are used mainly for bolting rats, rabbits, and other animals from dens. A license is required to keep a ferret in Pennsylvania and a permit in Wisconsin. Their use in hunting rabbits is forbidden by law in Delaware, Illinois, Maine, Maryland, Massachusetts, Michigan, New Jersey, Pennsylvania, Rhode Island, and Wisconsin (except in Door County); forbidden, except on one's own premises, in Indiana, Kentucky, New Hampshire, Ohio, and West Virginia, and in Shenandoah County, Va.; forbidden in New York except in such counties as have received permission to use them from the conservation commission; also in Vermont, where they may be used to bolt but not to capture rabbits.

Table I affords comparison of the length, in days, of open seasons for trapping the more important fur animals. Alabama, Arizona, the District of Columbia, Massachusetts, Texas, and Yukon have no close seasons. Colorado, Montana, Nevada, New Mexico, and Wyoming have no open season for beavers and no close seasons for other fur bearers. Idaho and Utah have no open season for beavers and otters; California, none for beavers or sea otters; Washington, no open season for beavers and a close season for bears only; Mississippi has no close season for fur animals except bears, while Georgia has none except for opossums.

TABLE I.—*Length (in days) of open seasons for trapping various fur animals, 1917.*

State or Province.	Beaver.	Otter.	Muskrat.	Mink.	Marten.	Fisher.	Skunk.	Raccoon.	Opossum.	Fox.	Bear.
Alabama	(1)	(1)	(1)	(1)	.....	.....	(1)	(1)	(1)	(1)	(1)
Alaska	0	136	182	136	0	.....	.....	.....	.....	119	.....
Arizona	(1)	(1)	(1)	(1)	.....	.....	(1)	(1)	.....	(1)	(1)
Arkansas	0	0	151	151	.....	.....	151	151	151	151	51
California	0	120	.....	120	120	120	120	120	.....	120	120
Colorado	0	(1)	(1)	(1)	(1)	.....	(1)	(1)	.....	(1)	(1)
Connecticut	.....	151	(1)	(1)	.....	.....	181	136	(1)	(1)	.....
Delaware	.....	0	[2] 126	115	.....	.....	115	138	138	212	.....
District of Columbia	.....	(1)	(1)	(1)	.....	.....	(1)	(1)	(1)	(1)	.....
Florida	92	92	.....	(1)	.....	.....	(1)	(1)	(1)	(1)	(1)
Georgia	(1)	(1)	(1)	(1)	.....	.....	(1)	(1)	151	(1)	(1)
Idaho	0	0	(1)	(1)	(1)	(1)	(1)	(1)	.....	(1)	(1)
Illinois	.....	151	151	151	.....	.....	151	151	151	(1)	.....
Indiana	74	74	151	151	.....	.....	74	74	74	74	.....
Iowa	121	121	121	121	.....	.....	(1)	(1)	(1)	(1)	.....
Kansas	0	0	121	121	.....	.....	121	121	121	(1)	.....
Kentucky	47	47	(1)	47	.....	.....	47	47	47	(1)	.....
Louisiana	107	107	107	107	.....	.....	107	107	107	107	92
Maine	0	137	[3] 198	137	137	137	137	.....	.....	137	(1)
Maryland [4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Massachusetts	.....	(1)	(1)	(1)	.....	.....	(1)	(1)	.....	(1)	.....
Michigan	[5] 195	119	119	119	119	119	119	119	.....	(1)	.....
Minnesota	0	0	136	136	(1)	(1)	(1)	(1)	.....	(1)	138
Mississippi	(1)	(1)	(1)	(1)	.....	.....	(1)	(1)	(1)	(1)	120
Missouri	63	63	63	63	.....	.....	63	63	63	63	.....
Montana	[5] 0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	.....	(1)	(1)
Nebraska	0	107	107	107	.....	.....	.....	107	107	.....	.....
Nevada	0	(1)	(1)	(1)	.....	.....	(1)	(1)	.....	(1)	(1)
New Hampshire	0	120	120	120	120	120	120	120	.....	120	.....
New Jersey	0	138	138	138	.....	.....	138	76	(1)	(1)	.....
New Mexico	0	(1)	(1)	(1)	.....	.....	(1)	(1)	.....	(1)	(1)
New York	0	(1)	162	126	126	(1)	93	126	(1)	(1)	(1)
North Carolina [4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North Dakota	60	60	150	150	.....	.....	(1)	(1)	.....	(1)	.....
Ohio	.....	(1)	79	79	.....	.....	79	.....	79	100	.....
Oklahoma	0	0	121	121	.....	.....	121	121	121	121	.....
Oregon	[3] 0	120	120	120	120	120	(1)	(1)	.....	(1)	(1)
Pennsylvania	0	(1)	(1)	(1)	(1)	(1)	(1)	122	(1)	(1)	62
Rhode Island	.....	(1)	165	165	.....	.....	165	165	.....	(1)	.....
South Carolina [4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
South Dakota	121	121	121	121	.....	.....	(1)	(1)	.....	(1)	.....
Tennessee [3]	92	92	92	92	.....	.....	92	92	92	92	.....
Texas	(1)	(1)	(1)	(1)	.....	.....	(1)	(1)	(1)	(1)	.....
Utah	0	0	(1)	(1)	.....	.....	(1)	(1)	.....	(1)	(1)
Vermont	0	181	[3] 181	181	163	163	163	163	.....	164	(1)
Virginia [4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Washington	0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	.....	(1)	242
West Virginia	.....	(1)	(1)	61	(1)	.....	61	61	(1)	61	.....
Wisconsin	[3] 0	0	[6] 178	79	79	79	79	79	.....	(1)	21
Wyoming	0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	.....	(1)	.....
Alberta	0	181	181	151	151	151	(1)	.....	.....	.....	.....
British Columbia	181	181	181	181	181	181	(1)	181	.....	136	.....
Manitoba—Northern	181	181	117	151	151	151	(1)	.....	.....	120	.....
Southern	0	0	75	151	151	151	(1)	.....	.....	(1)	.....
New Brunswick	[5] 0	151	51	151	0	151	(1)	(1)	.....	151	.....
Newfoundland	0	182	212	.....	182	.....	.....	(1)	.....	151	.....
Northwest Territories	226	226	226	195	195	195	.....	.....	.....	(1)	(1)
Nova Scotia	0	92	92	92	0	92	92	92	.....	92	.....
Ontario—Northern	0	0	50	181	(1)	(1)	(1)	(1)	.....	(1)	(1)
Southern	0	0	51	181	(1)	(1)	(1)	(1)	.....	(1)	.....
Prince Edward Island	0	151	151	151	151	.....	.....	.....	.....	(1)	.....
Quebec—Zone I	0	151	30	151	151	151	(1)	151	.....	151	(1)
Zone II	151	168	151	151	151	151	(1)	.....	.....	151	314
Saskatchewan	181	181	181	151	151	151	.....	.....	.....	[3] (1)	(1)
Yukon	(1)	(1)	(1)	(1)	(1)	(1)	.....	.....	.....	(1)	(1)

[1] No close season.
[2] Except Newcastle County.
[3] Local exceptions.
[4] Local county laws.
[5] Under special license only.
[6] In 18 counties, 188 days.

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W. L. McATEE
Assistant Biologist

FARMERS' BULLETIN 912
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief

Washington, D. C. February, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

BIRDS appeal strongly to the interests and affections of mankind. Not only do they charm by their graceful forms, harmonious colors, sprightly actions, and usually pleasing notes, but they have an even more important claim upon our esteem because of their great economic value.

Birds feed upon practically all insect pests. They are voracious, able to move freely from place to place, and exert a steady influence in keeping down the swelling tide of insect life.

For economic as well as for esthetic reasons, therefore, an effort should be made to attract and protect birds and to increase their numbers. Where proper measures of this kind have been taken an increase of several fold in the bird population has resulted, with decreased losses from depredations of injurious insects.

This bulletin is one of a series intended to describe the best methods of attracting birds in various parts of the United States, especially by providing a food supply and other accessories about the homestead. The area to which it is adapted is shown by the shaded portion of the map on page 3.

HOW TO ATTRACT BIRDS IN THE EAST CENTRAL STATES.

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MEANS OF ATTRACTING BIRDS.

THE MEANS of increasing the number of birds about the home are few and simple. They comprise adequate protection and the provision of suitable nesting places, food, and water. In a series of publications, of which this bulletin relating to the East Central States (fig. 1) is one,[1] it is planned to recommend practicable methods of attracting birds about homes in the various parts of the United States. Especial attention will be given to the value of fruit-bearing shrubs and trees, as less information relating to these as a means of attracting birds is available than concerning more widely known but not more important measures, as protection, winter feeding, and the supplying of nesting boxes and water. Furthermore, the last-named measures need not vary so much with the locality as does choice of fruit-bearing shrubs and trees.

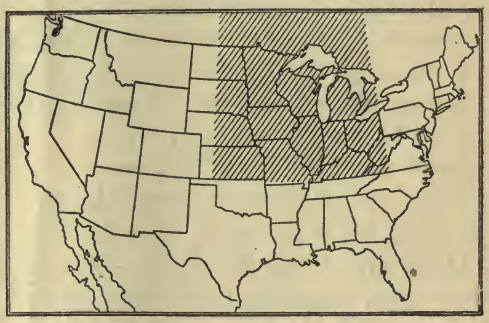

FIG. 1.—Map of the United States, the shaded area showing the territory to which this bulletin applies.

PROTECTION.

Protection is the prime requisite for increasing the number of birds in any area, and the results of protection are in direct proportion to its thoroughness. Besides being insured against every form of persecution by human kind, birds must be defended from various natural foes. The most effectual single step is to surround the pro-

[1] Bulletins already issued in the series are Farmers' Bulletins 621, relating to the Northeastern States; 760, to the Northwestern States; and 844, to the Middle Atlantic States.

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posed bird sanctuary with a vermin-proof fence (fig. 2). Such a fence should prevent entrance either by digging or by climbing, but will serve its greatest use if it can not be climbed and is therefore cat-proof. For this purpose the erect part of the fence above ground should be 6 feet high, and the mesh should measure not more than 1½ inches. The overhang should be 2 feet wide, and if strung with wires, these should be not more than 1½ inches apart. If it is impracticable to build an impenetrable fence, the next best device is to put guards (fig. 3) of sheet metal on all nesting trees and on poles supporting bird houses. This should be done in any case where squirrels or snakes are likely to intrude, as it is usually impossible to fence out these animals. Tree guards should be 6 feet or more above ground. Attacks by hawks, owls, crows, jays, or other enemies are best controlled by eliminating the destructive individuals. Those who wish to combat English sparrows will find full directions for so doing in Farmers' Bulletin 493.[1]

BREEDING PLACES.

Although a considerable number of our native birds build their nests on the ground, the majority place them in trees or shrubs, either in holes or on the limbs or in the crotches. Shrubbery and trees for nesting sites, therefore, are essential for making a place attractive to birds, and a double purpose is served if the kinds planted are chosen from the list of fruit-bearing species given farther on. Shrubs should be allowed to form thickets and should be pruned back severely when young so as to produce numerous crotches.

Constant removal of old trees, and modern tree-surgery, have resulted in a great diminution in the number of tree cavities, the

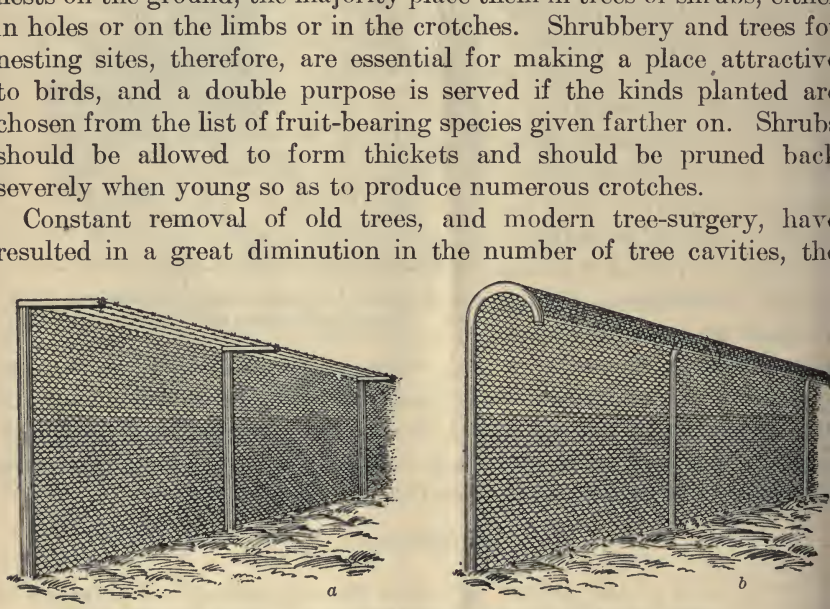

FIG. 2.—Cat-proof fences: *a*, With barbed wires; *b*, with loose overhanging netting.

natural homes of most of our hole-nesting birds. Fortunately most of these birds will utilize artificial nest cavities, or bird houses. The sizes useful for various birds, plans for making, and illustrations of numerous bird boxes are given in Farmers' Bulletin 609.[2] Styles

[1] Dearborn, Ned, "The English Sparrow as a Pest," revised, 1917.
[2] Dearborn, Ned, "Bird Houses and How to Build Them," 1914.

f bird houses may be varied almost endlessly. These structures nay be improvised by anyone, but they may be purchased also from umerous dealers.

The most common errors in putting out bird houses are choosing oor locations and supplying too many boxes. A bird house needs nly partial shade, and houses on poles usually are taken. Martins refer a house standing part from trees. Entrances o boxes should be shel- ered by projecting roofs nd should face away from he prevailing wind and rain torms. All bird houses hould be constructed so hat the interior may be asily examined and cleaned.

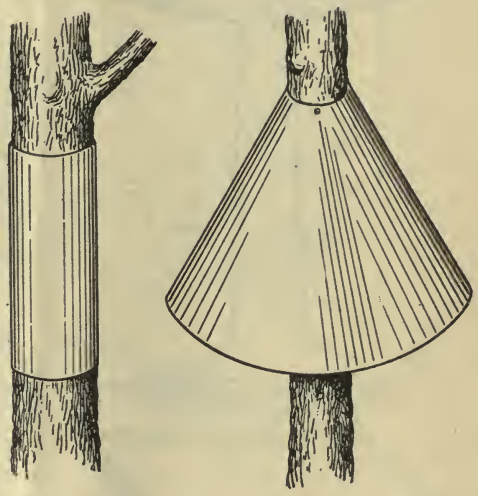

FIG. 3.—Tree guards.

As a rule birds do not like eing crowded, and if a place s studded with bird houses nly a few of them will be ccupied. Birds not only lo not want bird neighbors oo near, but are impatient f human meddling, and herefore should have as much privacy as possible during the actual ncubating and brooding. Nests built in shrubbery are especially iable to come to a bad end if the birds are disturbed frequently.

If ground-nesting birds, as bobolinks, meadowlarks, and bob- vhites, are to be protected, grass in the nesting fields must not be ut during the breeding season.

WATER SUPPLY.

Nothing has a more potent attraction for birds during hot weather han drinking and bathing places. The birds' water supply should be a pool not more than a few inches deep, the bottom sloping gradually ipward toward the edge. Both bottom and edge should be rough, o as to afford a safe footing. A giant pottery saucer (fig. 4, *a*) is an excellent device, or the pool may be made of concrete, or even metal, f the surface be roughened (fig. 4, *b*). The bird bath may be ele- vated, or on the ground if in an open space where skulking enemies can not approach too near.

A water supply is appreciated in winter as well as in summer; if running water can not be provided that supplied should be warmed o delay freezing.

FOOD SUPPLY.

Food supply is the vital factor in bird life and the most importan single offering that can be made in efforts to attract birds. It is im portant to note that an ample sup ply of food prior to and during th nesting season tends to increas the number of eggs laid and als the number of broods in a seasor Bird food may be supplied in tw ways—by planting trees, shrub and herbs which produce seeds o fruits relished by birds, and b exposing food in artificial device The most familiar phase of th latter method is winter feeding.

FIG. 4.—Bird baths: *a*, Pottery; *b*, metal or concrete.

ARTIFICIAL FOOD.

During the season when th natural food supply is at its lowes ebb, birds respond most readil to our hospitality. Winter feedin has become very popular, and th result has been to bring abou better understanding between birds and human kind.

The winter foods commonly used include suet or other fat, pork rinds, bones with shreds of meat, cooked meats, meal worms, cut-up apples, birdseed, buckwheat, crackers, crumbs, coconut meat, cracked corn, broken dog-biscuits or other bread, hemp seed, millet, nut meats of all kinds (especially peanuts), whole or rolled oats, peppers, popcorn, pumpkin or squash seeds, raw or boiled rice, sunflower seeds, and wheat. The waste product of grain mills, known as screenings, is a valuable and inexpensive source of food for birds.

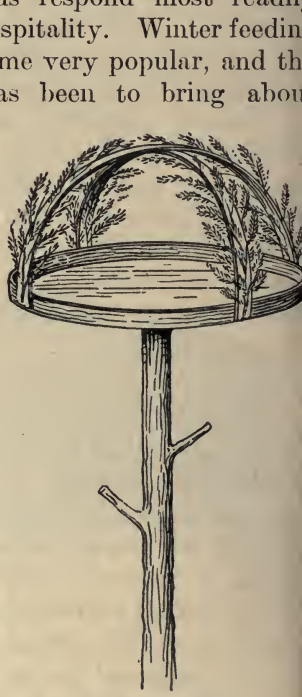

FIG. 5.—Food tray.

The methods of making these supplies available to birds are as varied as the dietary itself. A device very commonly used is the food tra or shelf (figs. 5 and 6). This may be put on a tree or pole by

window or at some other point about a building, or strung upon a wire or other support on which it may be run back and forth. The last device is useful in accustoming birds to feed nearer and nearer a comfortable observation point. A fault with food shelves is that wind and rain may sweep them clean and snow may cover the food. These defects may be obviated in part by adding a raised ledge about the margin or by placing the shelf in the shelter of a wall or shielding it with evergreen branches on one or more sides.

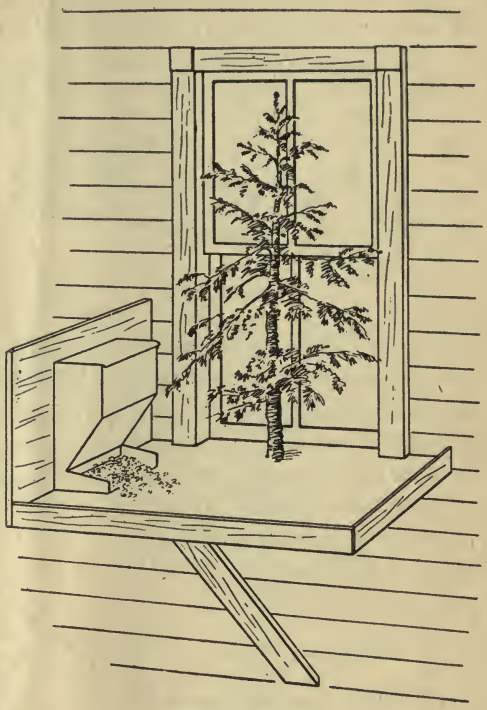

FIG. 6.—Food shelf.

Feeding devices not affected by the weather are preferable. An excellent one is a coconut with a hole made in one end (fig. 7). The cavity is filled with chopped suet and nuts or other food mixture, and the nut is suspended by a wire from a limb. The size of the hole regulates the character of the guests; if small, large birds can not gobble the supply. The coconut meat as well as the stuffing is eaten. Cans with small openings may be substituted for coconuts. Food baskets of any desired size made of wire netting or a metal grating may be hung up or fastened to the trunk of a tree. Food mixtures in melted fat may be poured into holes made in a branch or stick (fig. 8) or in cracks of bark or over evergreen branches. All of these devices minimize or counteract the disturbing effects of stormy weather.

FIG. 7.—Coconut larder.

More elaborate apparatus for the same purpose comprises various forms of food hoppers (figs. 6 and 9) and food houses. The food

hoppers in common use for domestic fowls are adapted to the feeding of birds, and some special forms are now manufactured for wild birds.

The food house is a permanent structure, with solid roof, and glass on one or more sides to permit observations (fig. 10). The food trays it contains are entirely sheltered from the weather. In one style this result is obtained by mounting the house on a pivot and furnishing it with vanes (fig. 11), which, if large enough, keep the open side always away from the wind.

FIG. 8.—Feeding stick.

Game birds and sparrows may be provided with feeding places by erecting low hutches or making wigwamlike shocks of corn or grain sheaves under which food may be scattered. The opening should be to the south.

Those who desire to have birds about their homes should not feel that their power to attract them is gone when winter is over. Winter feeding easily passes into summer feeding, and experience proves that some birds gladly avail themselves throughout the year of this easy mode of getting a living.

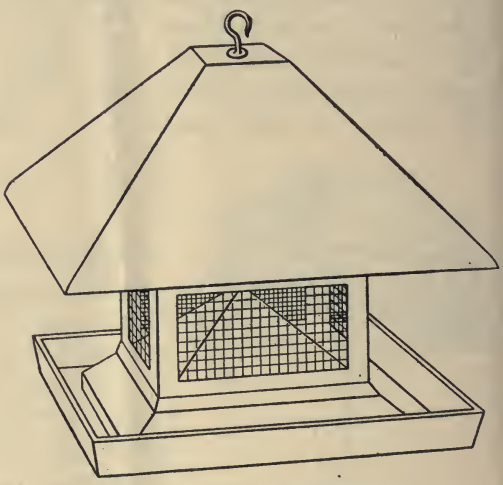

FIG. 9.—Food hopper (roof detachable).

NATURAL FOOD.

We have thus far considered ways of feeding birds tidbits we ourselves have gleaned. We may feed them by another method, by cultivating their natural food plants and allowing them to reap the harvest in their own way.

Less has been done in this respect for the true seed-eating birds than for those fond of pulpy fruits. The reason is obvious—our seed-eating birds largely patronize weeds, which we do not wish to cultivate, while the fruit eaters depend upon many plants which we hold in such esteem for their ornamental value that they are generally cultivated.

FEEDING SEED-EATING BIRDS.

Something can be done, however, to attract the seed eaters about our homes. A number of commonly cultivated annual plants, belonging to the same groups as those upon which the birds feed extensively in nature, produce good crops of seeds. These plants, being dependent upon cultivation, can be used without fear that they will become

pests. The following are suggested for the purpose: Prince's feather,[1] love-lies-bleeding,[2] asters, calandrinias, blessed-thistle,[3] centaureas, California poppies,[4] sunflowers, tarweed,[5] forget-me-nots, *Polygonum orientale* and *P. sachalinense*, *Portulaca*, *Silene*, and "sugar cane" (sorghum varieties).

The various millets are relished by nearly all seed-eating birds. Common millet,[6] Japanese millet or barnyard grass,[7] and German millet or Hungarian grass,[8] may be obtained from most seedsmen, and should be planted in abundance by those wishing to attract granivorous birds. The height and stiffness of stalk of varieties of sorghum should make these abundant seeders valuable in winter. Japanese millet holds its seeds well, and if planted thickly where it can grow up through a horizontal lattice work makes a valuable cover and feeding place for winter birds. Canary grass[9] and various species of *Pennisetum* also are good for seed-eating birds.

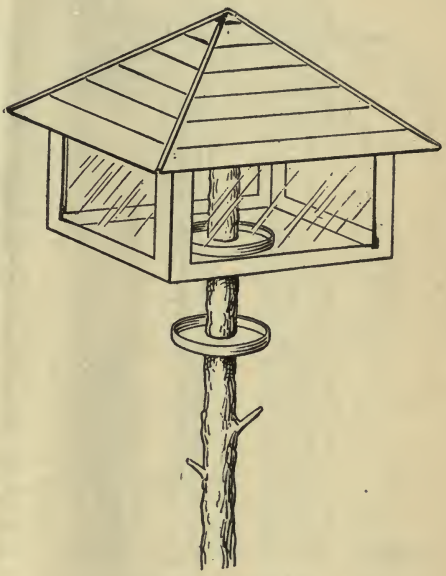

FIG. 10.—Food house.

Alders and birches bear in their numerous cones a supply of seeds which are eagerly sought for by redpolls, siskins, and goldfinches during the winter. Still another group of birds may be catered to by planting ashes and box elders. The winged fruits of these trees are opened and the seeds eaten by pine and evening grosbeaks, the visits of these birds being largely regulated by the supply of this kind of food. Larches, pines, and other conifers are attractive to crossbills as well as to some of the species just mentioned.

FEEDING FRUIT-EATING BIRDS.

Feeding fruit-eating birds is best accomplished by planting selected species of fruit-bearing shrubs and trees. Through late spring and summer there is usually an abundance of insect food, in addition to fruit enough for all the birds. So far as fruit alone is concerned, fall is the season of overflowing abundance; in winter the supply gradually decreases, and late winter and early spring are the seasons of actual scarcity. This is the critical time of year for many birds, and a plentiful supply of wild fruit will tide them over. Fortunately, everywhere in the United States there are some fruits that persist

[1] *Amarantus cruentus.*
[2] *A. caudatus.*
[3] *Carduus benedictus.*
[4] *Eschscholtzia.*
[5] *Madia elegans.*
[6] *Panicum miliaceum.*
[7] *Echinochloa crus-galli.*
[8] *Chætochloa italica.*
[9] *Phalaris canariensis.*

until there is no longer and need of them. If enough are planted, no birds able to live on this class of food should starve. The best of these long persisting fruits are juniper, bayberry, thorn apples and related fruits, holly, and snowberry.

Table I shows the relative popularity with birds of important genera of fleshy fruits. From these genera and a few others have been selected the species adapted to the East Central States, that make up Table II. Various considerations have influenced choice, as ornamental value, earliness, lateness, or length of fruiting season, and especially availability of the plants through ordinary channels of trade. The data on fruiting seasons have been compiled from the principal herbaria of the East Central States, with a few additions from other sources.

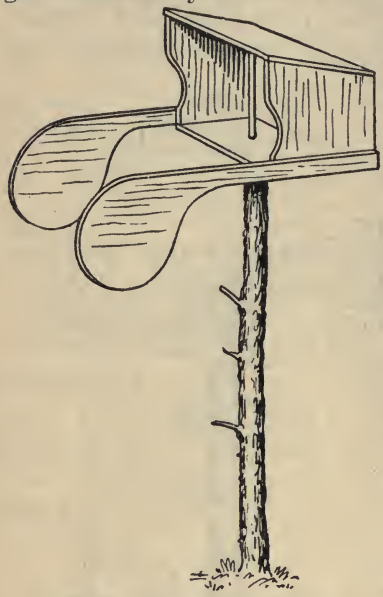

FIG. 11.—Food house on pivot.

The fruiting seasons indicated include the earliest and latest dates recorded for the East Central States. Hence it can not be expected that fruit will be available in any one locality throughout the entire bearing season of a plant unless a large number of plants are set out and in a variety of situations. Purchasers may obtain information from nursery catalogues as to where, when, and how to plant. Notes on species which may be substituted for some of those in the main list, and other comments, follow the table.

TABLE I.—*Preferences of birds among genera of fleshy fruits.*

Common name.	Scientific name.	Number of species of birds known to eat the fruit.[1]	Common name.	Scientific name.	Number of species of birds known to eat the fruit.[1]
Juniper; red cedar	*Juniperus*	36	Pepperberry	*Schinus*	10
Greenbrier	*Smilax*	38	Holly	*Ilex*	38
Bayberry	*Myrica*	64	Supple-jack	*Berchemia*	12
Hackberry	*Celtis*	38	Buckthorn	*Rhamnus*	16
Mulberry	*Morus*	52	Grape	*Vitis*	71
Pokeberry	*Phytolacca*	48	Virginia creeper	*Parthenocissus*	39
Barberry	*Berberis*	10	Buffaloberry	*Shepherdia*	13
Spicebush	*Benzoin*	17	Wild sarsaparilla	*Aralia*	14
Sassafras	*Sassafras*	15	Dogwood	*Cornus*	79
Current; gooseberry	*Ribes*	30	Sour gum	*Nyssa*	36
Strawberry	*Fragaria*	42	Bearberry	*Arctostaphylos*	12
Raspberry; blackberry.	*Rubus*	114	Huckleberry	*Gaylussacia*	30
			Blueberry	*Vaccinium*	62
Rose	*Rosa*	17	Mexican mulberry	*Callicarpa*	10
Mountain ash	*Sorbus*	14	Partridge berry	*Mitchella*	10
Chokeberry	*Aronia*	13	Elder	*Sambucus*	101
Red haw	*Crataegus*	30	Snowberry	*Symphoricarpos*	22
Juneberry	*Amelanchier*	38	Black haw	*Viburnum*	26
Cherry; plum	*Prunus*	66	Honeysuckle	*Lonicera*	15
Sumac[2]	*Rhus*	76			

[1] When 10 or more.

[2] Nonpoisonous species.

TABLE 11.—*Seasons of fruits attractive to birds.*

Common name.	Scientific name.	Native or introduced.	Fruiting season. Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Juniper [1]	*Juniperus communis*	Native												
Red cedar	*Juniperus virginiana*	do												
Greenbrier	*Smilax rotundifolia*	do												
Hackberry	*Celtis occidentalis*	do												
Red mulberry [2]	*Morus rubra*	do												
Pokeweed	*Phytolacca americana*	do												
Barberry	*Berberis vulgaris*	Introduced												
Spicebush	*Benzoin æstivale*	Native												
Sassafras	*Sassafras variifolium*	do												
Red currant [2]	*Ribes vulgare*	Introduced												
Wild black currant	*Ribes americanum*	Native												
Wild gooseberry [2]	*Ribes cynosbati*	do												
Wild strawberry	*Fragaria americana*	do												
Do	*Fragaria virginiana*	do												
Black raspberry	*Rubus occidentalis*	do												
Dewberry [2]	*Rubus procumbens*	do												
Meadow rose	*Rosa blanda*	do												
Mountain ash [1]	*Sorbus americana*	do												
Flowering apple	*Pyrus floribunda*	Introduced												
Chokeberry	*Pyrus melanocarpa*	Native												
Juneberry [2]	*Amelanchier canadensis*	do												
Red haw	*Cratægus coccinea*	do												
Washington thorn [3]	*Cratægus phænopyrum*	do												
Bird cherry	*Prunus pennsylvanica*	do												
Wild black cherry	*Prunus serotina*	do												
Fragrant sumac	*Rhus aromatica*	do												
Smooth sumac	*Rhus glabra*	do												
Evergreen holly [2]	*Ilex opaca*	do												
Swamp holly [2 3]	*Ilex decidua*	do												
Black alder	*Ilex verticillata*	do												

[1] Available only in South during about first month of season shown.
[2] Native only in southern part of area; may be cultivated elsewhere.
[3] Native only in northern part of area; may be cultivated elsewhere.

TABLE II.—*Seasons of fruits attractive to birds*—Continued.

Common name.	Scientific name.	Native or introduced.	Fruiting season.
			Jan. Feb. Mar. Apr. May. June. July. Aug. Sept. Oct. Nov. Dec.
Bittersweet	*Celastrus scandens*	Native	
Buckthorn	*Rhamnus alnifolia*	do	
Summer grape	*Vitis æstivalis*	do	
River grape	*Vitis vulpina*	do	
Ampelopsis [1] [2]	*Ampelopsis cordata*	do	
Virginia creeper	*Parthenocissus quinquefolia*	do	
Buffalo berry [3]	*Shepherdia canadensis*	do	
Wild sarsaparilla	*Aralia nudicalis*	do	
White dogwood	*Cornus paniculata*	do	
Flowering dogwood	*Cornus florida*	do	
Red osier	*Cornus stolonifera*	do	
Sour gum	*Nyssa sylvatica*	do	
Wintergreen [3]	*Gaultheria procumbens*	do	
Bearberry	*Artostaphylos uva-ursi*	do	
Black huckleberry	*Gaylussacia baccata*	do	
Early sweet blueberry	*Vaccinium pennsylvanicum*	do	
Canada blueberry [3]	*Vaccinium canadense*	do	
Persimmon	*Diospyros virginiana*	do	
Privet	*Ligustrum vulgare*	Introduced	
Partridge berry	*Mitchella repens*	Native	
Common elder	*Sambucus canadensis*	do	
Red-berried elder [3]	*Sambucus racemosa*	do	
Arrowwood	*Viburnum acerifolium*	do	
Do	*Viburnum dentatum*	do	
Sheepberry	*Viburnum lentago*	do	
High-bush cranberry	*Viburnum opulus*	do	
Snowberry	*Symphoricarpos racemosus*	do	
Fly honeysuckle [3]	*Lonicera cærulea*	do	
Glaucous honeysuckle	*Lonicera dioica*	do	
Sullivant's honeysuckle	*Lonicera sullivantii*	do	

[1] Available only in South during about first month of season shown.
[2] Native only in southern part of area; may be cultivated elsewhere.
[3] Native only in northern part of area; may be cultivated elsewhere.

NOTES ON TABLE II.

Juniper. *Juniperus horizontalis* holds its fruit as well as the others but is easily covered by snow. Yew (*Taxus canadensis*), season middle of July to middle of September, should be mentioned here. It is ornamental, furnishes bird food, and may be cultivated anywhere in this area.

Hackberry. *Celtis mississippiensis* may be substituted in the south.

Mulberry. *Morus alba* and *M. tatarica* also may be used.

Pokeweed. Let it grow through shrubs or a trellis which will support it in winter.

Strawberry. Little dealt in; must usually be transplanted from woods and fields.

Dewberry. *Rubus triflorus* suited to wet situations, *R. canadensis* for the north, and *R. hispidus* are good substitutes.

Rose. *Rosa setigera*, *R. virginiana* (*lucida*), and *R. carolina* may be substituted. The last is adapted to wet places.

Chokeberry. Often called *Pyrus* or *Aronia nigra*. *P. arbutifolia*, another native species, retains its fruit just as long, but the fruit becomes very dry toward the end of the season.

Juneberry. *Amelanchier canadensis*, sold by nurserymen, is a composite species. Several species are now recognized, among which *A. lævis* is a notably early fruiter and *A. sanguinea* a late one. Some fruit of juneberries occasionally hangs much later than the season indicated, but in very dry condition.

Thorns. The species recommended are those usual in the trade; most others will serve as well.

Cherry. *Prunus pumila*, a low plant of sandy areas, and *P. virginiana* also may be used.

Sumac. *Rhus copallina* or *R. hirta* may be substituted.

Buckthorn. The introduced *Rhamnus cathartica* may be used; it retains fruit until late spring.

Grape. *Vitis cordifolia* may be added.

Virginia creeper. Often listed under the names *Ampelopsis* and *Parthenocissus*. The Japanese creeper or Boston ivy (*P. tricuspidata*) is a good introduced substitute.

Buffaloberry. *Shepherdia* (*Lepargyrea*) *argentea*, the true buffaloberry, furnishes good bird food. Other plants in this family, the oleasters (*Elæagnus longipes*, *E. angustifolia*, *E. multiflora*, *E. parviflora*, and *E. umbellata* also are good.

Wild sarsaparilla. *Aralia racemosa* may be substituted.

Dogwood. *Cornus alternifolia* and *C. asperifolia*, native, and *C. alba* and *C. sanguinea*, introduced, are worthy substitutes.

Huckleberry. *Gaylussacia baccata* is often sold as *G. resinosa*.

Blueberry. Any native species may be substituted.

Privet. *Ligustrum acuminatum*, *L. amurense*, *L. ciliatum*, *L. ibota*, and *L. microcarpum*, all introduced, are equally good. Must not be clipped; berries borne on outer twigs.

Snowberry. *Symphoricarpus occidentalis* is just as good.

PROTECTING CULTIVATED FRUITS.

Birds devour cultivated fruit principally because the processes of cultivation diminish the wild supply. The presence of wild fruit in a locality always serves to protect domestic varieties, especially when the wild trees or shrubs are of the same kinds as the cultivated ones and ripen earlier. Among those most useful for the purpose are mulberry, wild blackberries and strawberries, Juneberry, wild cherry, and elderberry. Species suitable for the East Central States are shown in Table III.

TABLE III—*Seasons of fruits useful to protect cultivated varieties.*

Common name.	Scientific name.	Native or introduced.	To protect—	Fruiting season.
				May. June. July. Aug. Sept. Oct. Nov. Dec.
Wild strawberry	*Fragaria virginiana*	Native	Strawberries	
Dewberry	*Rubus procumbens*	do	Raspberries and blackberries	
Wild blackberry	*Rubus americanus*	do	do	
Do	*Rubus canadensis*	do	do	
Wild gooseberry	*Ribes cnyosbati*	do	do	
Red mulberry	*Morus rubra*	do	Cherries	
White mulberry	*Morus alba*	Introduced	do	
Juneberry	*A melanchier canadensis*	Native	do	
Wild red cherry	*Prunus pennsylvanica*	do	do	
Glaucous honeysuckle	*Lonicera dioica*	do	do	
Red-berried elder	*Sambucus racemosa*	do	do	
Flowering crabapple	*Pyrus floribunda*	Introduced	Apples and pears	
Western crabapple	*Pyrus ioensis*	Native	do	
Chokeberry	*Pyrus melanocarpa*	do	do	
Cockspur thorn	*Cratægus crus-galli*	do	do	
White thorn	*Cratægus punctata*	do	do	

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KILLING HOGS AND CURING PORK

F. G. ASHBROOK
AND
G. A. ANTHONY
Animal Husbandry Division

FARMERS' BULLETIN 913
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. December, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

CHOICE HAM AND BREAKFAST BACON can be produced by the farmer for much less than the cost of purchased meat.

The cheapest meat a farmer can use is the product of his own farm.

This is also true of the suburban or town farmer who fattens one or two hogs on kitchen and truck-garden wastes.

Many farmers, for the first time, this year will have their own meat supply.

Home-cured pork of the right kind always has a ready market and in many cases it will prove the best way to market hogs.

The home curing of pork is a good practice and should be more extensively adopted.

This publication explains how to slaughter hogs and cure pork. Butchering and cutting up the carcass, lard rendering, brine and dry curing, smoking, and sausage making are all discussed in the following pages.

KILLING HOGS AND CURING PORK.

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TOO MANY FARMERS buy a part or all of their supply of meat from local stores and hucksters. Meat, especially pork, can be grown and cured at home for much less than the cost of the purchased meat, to say nothing of a ready market for good country-cured hams, shoulders, and sides. In spite of this the custom of farmers purchasing cured meats is increasing. It may not be practicable for every farmer to butcher and cure his own meat, but in nearly every community a few farmers could do this and make good profits. Farmers who sell country-cured meats have experienced very little difficulty in establishing a permanent trade. To accomplish this one must understand the kind of cured meat his trade demands, and also how it is made. Country-cured meat often carries too much fat and undesirable odors, and it is generally too salty. A well marbled, juicy, savory piece of meat showing the proper admixture of fat and lean and possessing a good flavor is the kind the consumer desires.

SELECTION OF HOGS FOR BUTCHERING.

HEALTH.

In selecting hogs for butchering, health should have first consideration. Even though the hog has been properly fed and carries a prime finish, the best quality of meat can not be obtained if the animal is unhealthy; there is always some danger that disease may be transmitted to the person who eats the meat. The keeping quality of the meat is always impaired by fever or other derangements.

CONDITION.

A hog in medium condition, gaining rapidly in weight, yields th best quality of meat. Do not kill a hog that is losing flesh. A reason able amount of fat gives juiciness and flavor to the meat, but larg amounts of fat are not essential.

QUALITY.

The breeding of animals plays an important part in producing carcass of high quality. Selection, long continued care and intelligen feeding will produce meat of desirable quality. The smooth, even and deeply fleshed hogs will yield the nicely marbled meat.

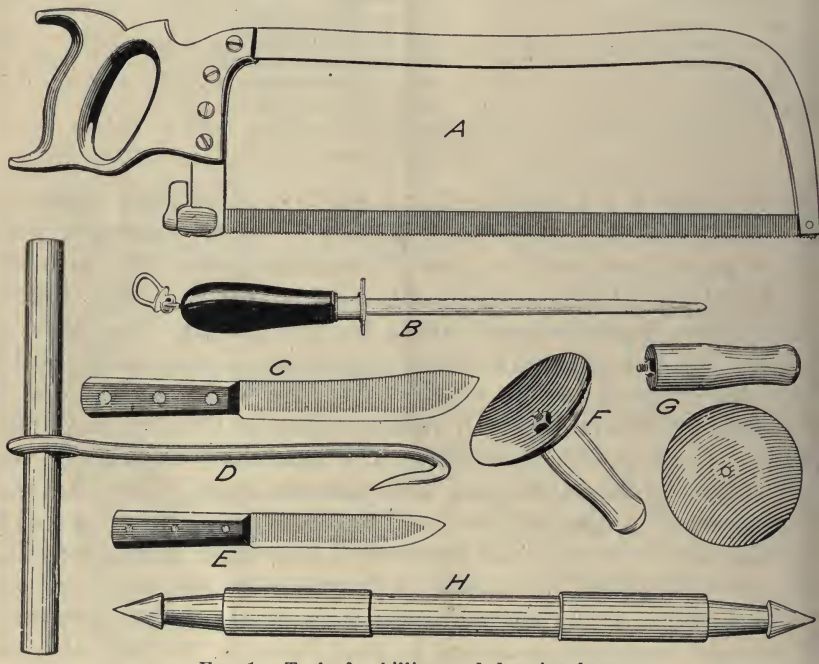

FIG. 1.—Tools for killing and dressing hogs.

AGE FOR KILLING.

The meat from very young hogs lacks flavor and is watery. Ol meat is generally very tough. The meat of old hogs can be improved however, if they are properly fattened before slaughter. Hogs ca be killed for meat any time after 8 weeks, but the most profitabl age at which to slaughter is 8 to 12 months.

CARE BEFORE KILLING.

Hogs intended for slaughter should remain unfed for at least 24 hours, or better, 30 hours. Give them all the clean, fresh water they will drink. This will help to clear the system of food and will facilitate bleeding. Do not excite or whip a hog before killing. An excited hog never makes a good carcass, and whipping causes bruised hams, which are not fit to cure. An injured hog may be used for food provided it is bled immediately.

EQUIPMENT FOR SLAUGHTERING.

It is essential to have the proper equipment for rapid and skillful work at killing time: An 8-inch straight sticking knife, a cutting

FIG. 2.—Position for sticking the hog.

knife, a 14-inch steel, a hog hook, a bell-shaped stick scraper, a gambrel, and a meat saw (fig. 1). More than one of each of these tools may be necessary if many hogs are to be slaughtered and handled to best advantage. A barrel is a very convenient receptacle in which to scald hogs. The barrel should be placed at an angle of about 45 degrees at the end of a table or platform of proper height. The table and barrel should be securely fastened to prevent accident to the workmen due to slipping. A block and tackle will reduce labor. All the tools and apparatus should be in readiness before beginning.

KILLING AND DRESSING.

Ordinarily it is not necessary to stun or shoot a hog before sticking although this is done in some localities for humane reasons. If the hog is stuck without being stunned, he should be squarely on his back when stuck. Two men can reach under and grasp the legs on the opposite side of the body and with a quick jerk turn the hog over on his back. One man can stand astride the body with his legs just back of the hog's shoulders, taking a good grip on the forelegs (fig. 2). In this position the hog can be held in place while the other man does the sticking.

STICKING.

A narrow, straight-bladed knife, 8 inches long, serves very well for sticking a hog. The knife should be pointed directly toward

FIG. 3.—A convenient arrangement for scalding.

the root of the tail and held in a line with the backbone. Thrust the knife in 6 or 8 inches directly in front of the breastbone. The knife should be kept in a straight line so as not to stick a shoulder, causing blood to clot, which results in waste in trimming or a shoulder which keeps poorly. After the knife has been inserted 6 or 7 inches, turn it and withdraw. This severs the arteries in the neck and will insure better bleeding. Avoid sticking the heart, for if this is done the blood will not be pumped from the arteries. After sticking, the hog may be turned over on the side.

SCALDING AND SCRAPING.

The handiest way of heating water for scalding is in a large caldron or a kettle built for scalding hogs and which is placed over a fire near the place of butchering. A barrel is the most convenient receptacle in which to scald a hog, unless the hog is too large for the barrel, in which case a tank must be used. The best arrangement for most efficient scalding is shown in figure 3, and previously described in the paragraph entitled "Equipment for slaughtering." Much of the heavy labor can be avoided by means of a hoist, such as a block and tackle, for lifting the hog in and out of the scalding vat or when hanging the hog for removing the entrails.

If the water is heated in the house, it should be boiling when removed from the stove and carried to the barrel. At the time the hog is scalded the water should be at a temperature of 185° to 195° F. If no thermometer is at hand, stick the finger into the water three times in rapid succession, and if it burns severely the third time the water is about right. If the water is too hot the hair is likely to set, causing even more trouble than if too cold. A teaspoonful of lye or a small shovelful of wood ashes added to every 30 gallons of water will aid in removing the scurf. After either one of these alkalis is added the water should be stirred thoroughly.

Insert the hog hook in the lower jaw, place the hog on the table, and slide it into the barrel (fig. 3). The rear end of the hog is scalded first for the reason that if the water is too hot and the hair sets it can be removed easier from the rear than from the fore part of the hog. The hog should be kept moving in the water to be sure that no part will rest against the side of the barrel. Occasionally the hog should be drawn out of the water to air, when the hair may be "tried." When the hair and scurf slip easily from the surface, scalding is complete. Pull the hog out upon the table and remove the hair and scurf from the legs and feet at once. The simplest way to accomplish this is to twist the legs in both hands. Use the hog hook to remove the dewclaws at the same time. Remove the hair and scurf from the rear end of the hog by means of a bell-shaped scraper.

Cut the skin about 3 or 4 inches long just below the hocks in both hind legs. Loosen the tendons and insert the gambrel. Be sure that both tendons in each leg are loosened before inserting the gambrel. Now scald the front part of the hog. After the front part of the hog is scalded pull it out on the table as before. Remove the hair and scurf from the ears, forelegs, and head immediately, as these parts cool very quickly. Use the bell-shaped scraper to remove the remaining hair and scurf. If the hair fails to yield in any particular region, cover that portion with a gunny sack and pour on hot water.

When most of the hair and scurf is removed pour hot water over the entire carcass and shave off, by means of a knife, the hair that is left. Hang up the hog and pour a bucketful of cold water over the carcass and scrape from the surface the remaining dirt or scurf.

REMOVING ENTRAILS.

After the hog is hung up and the surface is clean the next step is to remove the entrails. Cut through the midline, beginning at the top and continue cutting down to the head. Cut around the rectum on each side and pull it out between the pelvic bones.

FIG. 4.—Removing the intestines.

Place the knife between the first and second fingers of the left hand, inserting the fingers where the opening has been made and with the right hand force the knife down to the breastbone (fig. 4). The fingers will serve as a guide in making the cut and protect the intestines from being cut. When this opening has been made remove the fat which surrounds the stomach. Then remove the intestines and stomach, cutting the gullet as soon as it is drawn up far enough. Cut on each side of the tongue to loosen it and pull it out with an upward jerk. Now cut through the breastbone, beginning at the front end. Cut upward slightly to one side. Remove the pluck,

which consists of the heart, lungs, gullet, and windpipe, by cutting the diaphragm. This is the membrane which separates the organs of the chest from the stomach, bowels, and other abdominal organs. Cut just between the light and dark portions of the diaphragm.

Cut down along the backbone and it will be easy to pull out the entire pluck. Put a piece of corncob or small block of wood in the hog's mouth so air can circulate. Wash out the inside of the carcass with cold water and a cloth. Take a stick about a foot or 18 inches long and spread open the sides, allowing a free circulation of air. To facilitate cooling, the head can be removed and the carcass split or sawed down the backbone. In splitting or sawing the carcass be careful to cut as near the midline as possible.

THE LEAF LARD.

While the carcass is still warm, remove the leaf lard or kidney fat. This facilitates cooling the carcass and lessens the danger of the hams and loins souring. The leaf lard should be spread out on a table to cool, with the thin membrane side turned down. The gut fat should not be mixed with the leaf lard in rendering.

COOLING THE CARCASS.

The carcass should be cooled after slaughtering, but not allowed to freeze. Temperature can not be controlled on the farm, but it is possible to kill when the weather is favorable. Select a day in winter when there is chance for cooling the carcass before the surface freezes. The desirable temperature for cooling meat is 34 to 40° F. In the summer time it is necessary to have refrigeration. In the fall it is best to kill in the evening, allowing the carcass to cool overnight. Hang the carcass in a dark cellar or a cool room in the barn before the flies can get at it. Freshly killed meat absorbs odors very readily; do not hang the carcass in a freshly painted room or in a room with tar, kerosene, or gasoline.

A pork carcass should not be cut up until it is thoroughly cooled.

CUTTING UP HOGS.

The usual farm method of cutting up a hog is to sever the ribs on each side of the backbone, take out the backbone, and split the carcass down the mid-line. The ribs are taken out before the sides are "blocked." Another method is to split with a saw or cleaver as near the midline as possible. Then divide each half into four parts, head, shoulder, middle, and hams, as shown in figure 5, left side. Remove the leaf if this was not done before. Peel the leaf backward with the fingers, starting at the front end. The kidneys are in this fat.

HEAD.

The head is generally removed before the carcass is split into halves. Cut about an inch back of the ears, making a complete circle around the head. If the cut does not happen to strike the atlas joint,

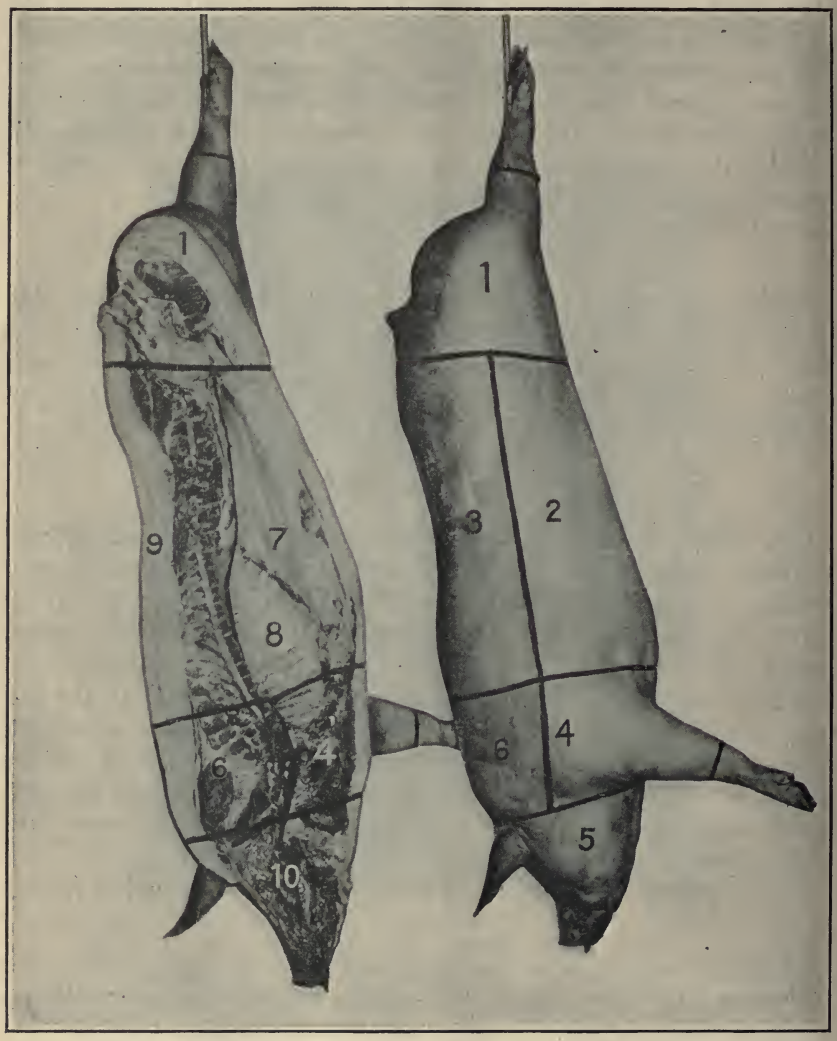

FIG. 5.—Cuts of pork: 1. Ham. 2. Bacon. 3. Loin. 4. Shoulder. 5. Head. 6. Plate. 7. Leaf lard. 8. Ribs. 9. Fat back.

twist the head and it will yield. The fattest part of the head can be used for lard and the more fleshy parts may be used for sausage or headcheese. The jowl is sometimes used for cooking with sauerkraut or baked beans and in the spring with turnip greens.

SHOULDER.

One-half the carcass should be placed on a cutting table and cut up into the various cuts shown in figure 5. Cut off the front foot about 1 inch above the knee and the hind foot the same distance above the hock. The feet can be used to make pickled pigs' feet or

FIG. 6.—The shoulder cuts and trimmings.

pigs' feet jelly. The shoulder cut is made between the fourth and fifth ribs. Remove the ribs from the shoulder, also the piece of backbone which may be attached. Cut close to the ribs in removing them so as to leave as much meat on the shoulder as possible.

FIG. 7.—Loin, loin trimmings, and fat back.

These are "spare ribs" and make an excellent dish when fried or baked. If only a small amount of cured meat is desired, the top of the shoulder may be cut off about one-third the distance from the top and parallel to it (fig. 6). The fat of the shoulder top may be used for lard and the lean meat for steak or roasts. It should be trimmed up smoothly. The fat trimmings should be used for lard and the lean trimmings for sausage.

MIDDLE.

The ham is removed from the middle by cutting just back of the rise in the backbone. Cut from the flank toward the root of the tail to an angle of about 45°. Loin meat is thus saved which would otherwise be trimmed off the ham and used for sausage. Remove the ribs from the side, cutting as close to the ribs as possible. The loin and fatback are cut off in one piece; cut parallel with the back just below the tenderloin muscle on the rear part of the middle. Remove the fat on the top of the loin, but do not cut into the loin meat (fig. 7). The lean meat is used for chops or roasts and the fatback for lard. The remainder of the middle should then be trimmed for bacon. If it is a very large side it may be cut in two pieces. Trim all sides and edges as square as possible (fig. 9).

HAM.

All rough and hanging pieces of meat should be trimmed from the ham. The ham should then be trimmed smoothly, exposing as little lean meat as possible, because the curing hardens it (fig. 8). All lean trimmings should be saved for sausage and fat trimmings for lard. The other half of the carcass should be cut up in similar fashion.

MEAT TRIMMINGS AND FAT TRIMMINGS.

After the carcass has been cut up and the pieces are trimmed and shaped properly for the curing process, there are considerable pieces

FIG. 8.—Ham and ham trimmings.

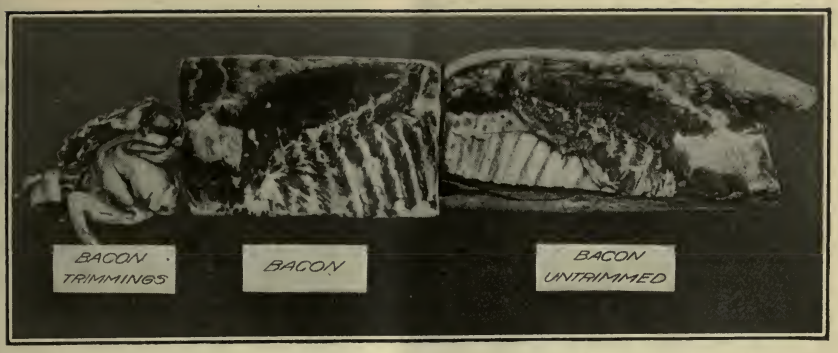

FIG. 9.—A side of bacon and bacon trimmings.

of lean meat, fat meat, and fat which can be used for making sausage and lard. The fat should be separated from the lean and used for lard. The meat should be cut into convenient pieces to pass through the grinder.

RENDERING LARD.

The leaf lard is of the best quality. The back strip of the side also makes good lard, as do the trimmings of the ham, shoulder, and neck. Intestinal or gut fat is an inferior grade and is best rendered by itself. It should be thoroughly washed and left in cold water for several hours before rendering, which will partially eliminate the offensive odor. Leaf lard, back strips, and lard trimmings can be rendered together. If the gut fat is included the lard takes on a very offensive odor.

First, remove all skin and lean meat from the lard trimmings. To do this cut the lard into strips about 1½ inches wide, then place the strip on the table, skin down, and cut the fat from the skin. When a piece of skin large enough to grasp is freed from the fat, take it in the left hand, knife held in the right hand inserted between the fat and skin, pull the skin and with the knife slanted downward slightly this will cleanly remove the fat from the skin. The strips of fat should then be cut into pieces of 1 to 1½ inches square, making them about equal in size so they try out evenly (fig. 10).

FIG. 10.—Pieces of fat cut for rendering.

Pour into the kettle about a quart of water, then fill it nearly full with the lard cuttings. The fat will then heat and bring out the grease without burning. Cook the lard over a moderate fire. When starting the temperature should be about 160° F. and should be run up to 195° F. Frequent stirring is necessary to prevent burning (fig. 11). When the cracklings are brown in color and light enough to float, the lard should be removed from the fire. Press the fat from the cracklings and use them to make crackling bread or feed them to the chickens. When the lard is removed from the fire, allow it to cool a little. To aid cooling stir the lard. This also tends to whiten the lard and make it smooth. Then strain it through a muslin cloth into the containers.

When removing lard from a container for use, take it off evenly from the surface exposed. Do not dig down into the lard and take out a scoopful for when this is done it will leave a thin coating around the sides of the container which will become rancid very quickly by the action of the air.

CURING PORK.

The first essential in curing is to make sure the pork is thoroughly cooled. Meat should never be frozen either prior to or during the period of curing.

The proper time to begin curing is when the meat is cooled and still fresh. Twenty-four to 36 hours after killing is the opportune time.

VESSELS FOR CURING.

A clean hardwood molasses or sirup barrel is a suitable vessel in which to cure pork. The barrel should be clean and tight so as to prevent leakage. A large stone or metal jar is the best container in which to cure meat, but the initial cost is high. Stone or metal containers are very easily kept clean. If a barrel is used repeatedly for curing pork it is necessary to scald it out thoroughly before fresh pork is packed into it.

CURING AGENTS.

Salt, saltpeter, sugar, and molasses are the principal preservatives used in curing pork. Borax, boric acid, formalin, salicylic acid, and other chemicals are sometimes used, but their use is prohibited in connection with meats and products to which the Federal meat-inspection law is applicable.

Salt when applied alone to meat makes it very hard and dry, because its action draws out the meat juices and hardens the muscle fibers. Saltpeter is used to preserve the natural color of the meat.

It is more astringent than salt and should be used sparingly. Sugar and molasses act differently than salt. They soften the muscle fibers and improve the flavor of the meat, hence the combination of salt and sugar make a good cure.

BRINE CURING AND DRY CURING.

Much diversity of opinion exists as to the merits of the two ways of curing—brining and dry curing. It is less trouble to pack meat in a barrel and pour on brine than to rub meat three or four times with salt. The brine keeps away insects and vermin. If directions are followed closely and pure water is used in making the brine, it will not spoil and should keep for a reasonable length of time. If

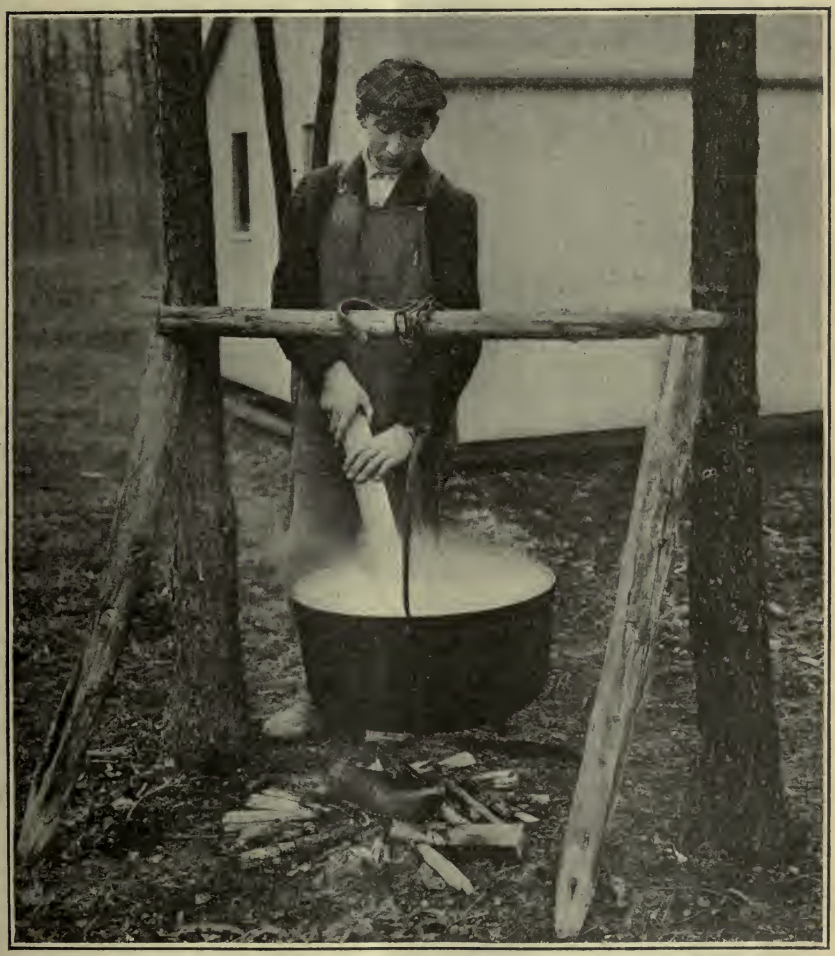

FIG. 11.—A suitable kettle for rendering lard.

the brine becomes "ropy," it should be poured off and boiled or a new brine made. A cool cellar is the most desirable place for both brine and dry curing, though more moisture is required for dry curing. When meat is cured during warm weather the dry salt method of curing is far safer than the brine method.

It is advisable to rub with fine salt the surface of the meat and allow it to drain, flesh side down, for 6 to 12 hours before being put in the cure. This applies to both brine and dry curing.

BRINE-CURED PORK.

There are many different formulas for curing pork by the brine method, but the recipe given below if followed closely will give very good results.

For each 100 pounds of meat use—

- 8 pounds salt.
- 2½ pounds sugar or sirup.
- 2 ounces saltpeter.
- 4 gallons of water.

In warm weather 9 or 10 pounds of salt are preferable.

Allow four days' cure for each pound in a ham or shoulder and three days for bacon and small pieces. For example, a 15-pound ham will take 60 days; a piece of bacon weighing 10 pounds, 30 days.

The brine should be made the day before it is used, so that it will be cool. All the ingredients are poured into the water and boiled until thoroughly mixed. Place ham on the bottom of the container, shoulders next, bacon sides and smaller cuts on top. Pour in the brine, and be sure it covers the meat thoroughly. In five days pour off the brine and change the meat, placing the top meat on the bottom and the bottom meat on top, then pour back the brine. Repeat this operation again on the tenth and eighteenth days. If the pickle becomes ropy, take out all the meat and wash it off thoroughly, also the container. Boil the ropy pickle; or, better, make new pickle. When each piece of meat has received the proper cure, take it out of the pickle and wash in lukewarm water, string, and hang in the smokehouse. (See page 26 for directions for smoking.) The temperature of the smokehouse should not exceed 125° F. Smoke the meat until it has a good chestnut color.

An excellent cure, in which the meat is preserved in brine formed from the mixture of the juices brought out of the meat by the application of the following ingredients:

For each 100 pounds of meat use—

- 8½ pounds salt.
- 2 pounds melted sugar or warm sirup.
- 2 ounces saltpeter.
- 2 ounces red pepper.
- 2 ounces black pepper.

All the ingredients should be mixed thoroughly. Rub each piece of meat with the mixture. Pack the meat in a container, hams on the bottom, shoulders next, and bacon sides on top. Enough liquid will be formed to cover the hams. Allow the meat to cure for six weeks; string and hang in the smokehouse. (See page 26 for directions for smoking.) The bacon and smaller pieces of meat, after they are cured, should be eaten first. The hams are better after they have aged.

DRY-CURED PORK.

Dry-cured pork requires more work than brine-cured, though it is sometimes less expensive. Danger from rats and other vermin is less in the case of brine-cured pork. Both methods of curing are very successful if care is taken to see that each operation is executed correctly. Following is the method of dry curing:

For each 100 pounds of meat use—

- 7 pounds salt.
- 2½ pounds sugar.
- 2 ounces saltpeter.

Mix all ingredients thoroughly, then rub one-third of the quantity of this mixture over the meat and pack it away in a box or on a table. The third day break bulk and rub on half of the remaining mixture over the meat and again pack the meat. Break bulk the seventh day and rub the remainder of the mixture over the meat and pack the meat to cure. Allow one day and a half cure for each pound the pieces of meat average. After the meat has cured, wash each piece with lukewarm water and hang in the smokehouse. (See page 26 for directions for smoking.)

Another dry cure is as follows:

For each 100 pounds of meat use—

- 8 pounds salt.
- 3 pounds warm syrup.
- 2 ounces saltpeter.
- 3 ounces black pepper.
- 2 ounces red pepper.

All the above ingredients should be mixed together thoroughly. Rub each piece of meat thoroughly with this mixture and pack the meat in bulk on a clean floor or table or in a container. In 10 days break bulk and repack the meat. This is done to make the cure more uniform and to prevent souring. Allow the meat to cure five or six weeks. (See page 26 for directions for smoking.)

PICKLED PORK.

Fat backs cut into suitable pieces for curing are generally treated in the following manner: The pieces of meat are packed in a con-

tainer and a pickle made of the following ingredients is poured over the meat: To 4 gallons of water add 10 pounds of salt and 2 ounces of saltpeter for each 100 pounds of meat.

THE SMITHFIELD HAM.

Smithfield hams are cured as follows:

The hams are placed in a large tray of fine Liverpool salt, then the flesh surface is sprinkled with finely ground crude saltpeter until the hams are as white as though covered by a moderate frost—or, say, use 3 to 4 pounds of the powdered saltpeter to the thousand pounds of green hams.

After applying the saltpeter, salt immediately with the Liverpool fine salt, covering well the entire surface. Now pack the hams in bulk, but not in piles more than 3 feet high. In ordinary weather the hams should remain thus for three days.

Then break bulk and resalt with the fine salt. The hams thus salted and resalted should now remain in salt in bulk one day for each and every pound each ham weighs—that is, a 10-pound ham should remain 10 days, and in like proportion of time for larger and smaller sizes.

Next wash with tepid water until the hams are thoroughly cleaned, and, after partially drying, rub the entire surface with finely ground black pepper.

Now the hams should be hung in the smokehouse and the important operation of smoking begun. The smoking should be done very gradually and slowly, lasting 30 to 40 days.

After the hams are cured and smoked they should be repeppered, to guard against vermin, and then bagged. These hams improve with age and are in perfection when 1 year old.

SAUSAGE.

If made into sausage, scraps and pieces of meat which otherwise would be wasted may be converted into delicious dishes. Sausage making is a trade well worth learning. Often on the farm when animals are butchered for home consumption portions of the carcass are not utilized to best advantage. A demand for fresh and smoked country sausage always exists, and it is just as important for every farmer to know how to make good sausage as it is to know how to make good hams and bacon.

The only equipment necessary to make sausage is a meat cutter with a stuffer attachment. A very convenient grinder can be purchased for $3, and stuffer attachment will cost about 35 cents. A

knife, cord string, and casings or muslin bags also will be needed. The muslin bags can be made any size, but the most convenient are 12 inches long by 2 inches in diameter. When sausage is stuffed in muslin bags it should be paraffined after stuffing. Sausage stuffed in muslin bags and paraffined keeps longer and better than sausage in casings. Sausage will keep very well in stone crocks or tin pans if a layer of lard or paraffin is put over the top.

PURE PORK SAUSAGE.

Good pork sausage may be made as follows: Take three parts of fresh lean meat to one part of fat. Add to each 100 pounds of meat 1½ to 2 pounds salt, 2 ounces fine sage, 1 ounce ground nutmeg, and 4 ounces black pepper. Cut the meat into small pieces and then put through the grinder, using the small plate. The spices should all be mixed together and added to the meat as it goes through

FIG. 12.—A display of various kinds of sausage.

the grinder. After it is well ground, mix thoroughly, to be sure that it is uniformly flavored. No water should be added if the sausage is stored away in bulk. If stuffed in casings, a little water is necessary to soften the meat so that it will slip through the stuffer into the casings.

SMOKED SAUSAGE OR COUNTRY SAUSAGE.

The following ingredients are used in making smoked or country sausage:

85 pounds lean pork.
15 pounds beef.
1½ to 2 pounds salt.
4 ounces black pepper.
1 ounce red pepper.
1 ounce sweet marjoram.
1 ounce mace.

Cut the meat into small pieces and sprinkle seasoning over it, then run through the grinder with the small plate. Put it away in a cool place for 24 to 36 hours, then add a little water, and stuff into hog casings and smoke in a very cool smoke until a dark mahogany color is obtained.

FRANKFORT OR VIENNA STYLE SAUSAGE.

Frankfort or Vienna style sausage is more popular with the manufacturers and the trade than any other kind of sausage. It is made as follows:

70 pounds beef.
30 pounds pork (not too lean).
20 pounds water.
1½ to 2 pounds salt.
2 ounces nutmeg.
¼ ounce black pepper.
1 to 2 ounces red pepper.

Cut the beef into small pieces and salt and allow it to cure for 48 hours in a cool place. Cut the pork into small pieces and put the beef and pork through the grinder together. Put into a container and add the water and spices. After it is all mixed, put it through the grinder again, using the fine plate. Stuff into sheep casings. After the sausage is stuffed into the casings by means of the thumb and forefinger, press the casing together, about 4 inches apart. Twist the first link two or three times. The next link made should be twisted in the opposite direction to keep the casing from untwisting. After it is twisted into links, hang it in the smokehouse for about 2 hours at a temperature not to exceed 125° F. After it is smoked, boil it for 5 or 10 minutes and then plunge it into cold water and hang it in a cool place.

BOLOGNA STYLE SAUSAGE.

Bologna style sausage is used extensively for lunches on picnics or outings. Its keeping qualities are excellent. The following ingredients are used in making it:

60 pounds cured beef.[1]
40 pounds pork.
20 pounds water.
1½ to 2 pounds salt.
2 ounces mace.
1 ounce coriander.
4 ounces black pepper.

Grind the beef and let it cure for 24 to 36 hours in a cool place, then grind it very fine. Put the pork through the grinder, using the medium plate only once. Then put the beef and pork together in a container and add the spices and water. Mix thoroughly until it takes on a dull color and becomes sticky. Stuff in wesands, large beef casings, or in beef rounds. Allow it to hang about 20 minutes in a cool place. This sausage can also be stuffed into muslin bags and paraffined. It will keep perfectly prepared in this way. Smoke for about 2 hours, or until a good color is obtained, at a temperature not to exceed 140° F. After the bologna is smoked it should be boiled, the wesands and rounds about 30 minutes and the larger bolognas about 1½ hours, at a temperature of 160° F. To tell when bologna is cooked enough, squeeze it in the hand, and if done it will squeak when the pressure is released. Place in cold water for about 30 minutes and then hang it up in a cool place to keep.

BLOOD SAUSAGE.

Blood sausage is made of the following ingredients:

25 pounds cured back or shoulder fat.
7 pounds cured fat skins.
6 pounds blood.
½ pound onions.
1 pound salt.
½ ounce white pepper.
1 ounce sweet marjoram.
¼ ounce cloves.

Cook the fat for about 1 hour and the skins 2 hours at a temperature of 200° F. When cooked put through grinder, using small or medium plate. Put into a container, add blood and seasoning, and mix thoroughly. Stuff into large beef casings and boil in the same water that the meat was cooked in until the sausage floats. Then dip the sausages into cold water and hang away to cool.

HEADCHEESE.

The head is generally used for making headcheese, but odds and ends also can be used. The head should be shaved clean, the snout

[1] Beef, ground, salt and seasoning added, and the bulk stored away for 36 to 48 hours before using it for sausage. Fresh meat stuffed into casings and smoked invariably spoils.

skinned and nostrils cut off just in front of the eyes. Cut out the eyes and the ear drums. The fattest part of the head is generally used for lard. When the head is cleaned, soak it in water for some time to extract the blood and dirt. After the head is thoroughly cleaned cover it with water and boil until the meat separates from the bones. Tongues and hearts may be cooked with the head. When this is thoroughly cooked take out the meat, saving the liquor for future use. Chop the meat up finely. Season with 1½ pounds salt, 3 ounces black pepper, 4 ounces allspice, and 4 ounces ground cloves, together with 2 gallons of the liquor for every 50 pounds of meat. This should all be mixed thoroughly so that proper seasoning is secured. If casings can be obtained, stuff the mixture into large beef casings. A hog stomach, after it is thoroughly cleaned, can be used. If the meat is stuffed into casings, it should be boiled again in the same liquor in which the meat was previously boiled. The meat in the casings should be boiled until it floats on the top, then placed in cold water for a short time. Store it away in a clean, cool place on a shelf or table. Place a board over the meat in the casings with a weight on top in order to hold the shape and to prevent the moisture from collecting in one spot. If there are no casings available in which to stuff the meat, it can be kept in shallow pans.

LIVER SAUSAGE OR PUDDING.

All the odds and ends resulting from cutting up the hog carcass can be used in making liver sausage. The head, if used, should be cleaned as previously described under "Headcheese." The jowl may be cut off and salted down. The head, liver cut into slices, and some beef or veal, if any is at hand, should all be put into a kettle and boiled. The skin cut from the fat can also be boiled with this meat. The skin will be cooked before the meat, so it should be put into a cloth sack and removed when thoroughly cooked. Livers also cook in a very short time, and should be removed. The meat should cook until it falls from the bones. All the meat should be ground, using the small grinder plate. Add 1½ pounds salt, 3 ounces sweet marjoram, 1 ounce allspice, 1 ounce black pepper, and about 1 gallon soup (the broth the meat was cooked in). Garlic or onions can be added if desired. This recipe is for every 40 pounds of meat. The seasoning should be worked into the meat. This finished product can be put into jars covered with paraffin or stuffed into beef rounds. When stuffed into casings, it should be cooked in the same water the meat was cooked in until the sausage floats. Then place in cold water until the sausage is thoroughly cooled.

SUMMER SAUSAGE.

The following ingredients are used to make summer sausage:

25 pounds cured beef free from sinews.
15 pounds pork trimmings.
6 ounces white pepper.
1 ounce whole black pepper.
1 ounce whole mustard seed.

This sausage can only be made in cold weather. All the meat is put through the grinder and spices added. No salt is needed, the cured beef being salty enough. Mix it all thoroughly until it is evenly seasoned. Spread it out in a cool place and leave it for 36 to 40 hours. Then stuff it into hog bung casings and let hang overnight. Smoke over very cool smoke for several days. This sausage can be kept in a dry place the year round. If it gets moldy, simply wipe off the mold before using it.

SCRAPPLE.

The head and feet of hogs are generally used in making scrapple, but scrapple can be made from any hog meat. The heads should be split through the middle and placed in a kettle with sufficient water to cover them. They should be cooked until the meat falls from the bones. Drain off the broth. Pick all the bones out of the meat, then chop the meat finely, add it to the broth and boil. Corn meal should be slowly added until it is as thick as mush. Add the corn meal slowly and stir vigorously, so as to avoid lumpiness. Stir the mixture well for 10 or 15 minutes and allow it to boil one hour, when it should be thick like mush. Pour the scrapple into shallow pans or molds. When cold, it can be sliced and fried.

SMOKING CURED MEAT.

The process of smoking helps to preserve the meat. Smoking also gives a desirable flavor to the meat, if it is smoked properly and with the right kind of fuel.

THE SMOKEHOUSE.

The smokehouse can be made any size and of the kind of material suitable to the demands of the owner. If a very small quantity of meat is to be smoked once a year, a barrel or a box (fig. 13) will answer. On the other hand, if a considerable quantity of meat is smoked and the house is to be permanent, it should be built of brick, concrete, or stone to be fireproof (figs. 14, 15.) A small outdwelling can be used if care is taken to confine the fire to the center of the room in an iron kettle. The safest method is to construct a fire pit

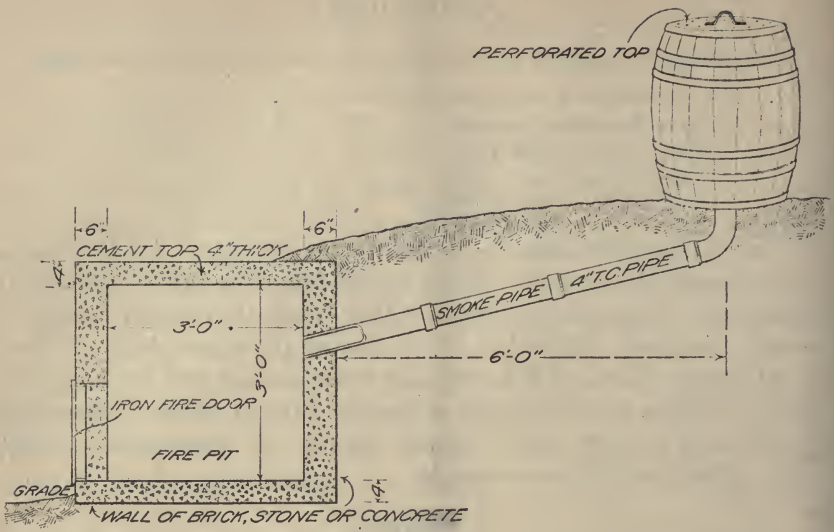

FIG. 13.—A type of smokehouse that can be constructed quickly and cheaply.

FIG. 14.—A farm smokehouse, fireproof and fairly tight.

outside of the house and pipe the smoke into the house. The pipe running from the pit to the house should be buried to prevent crushing.

A smokehouse 6 by 8 feet, 10 feet high, will give best results for general farm use. Ventilation should be provided to carry off the

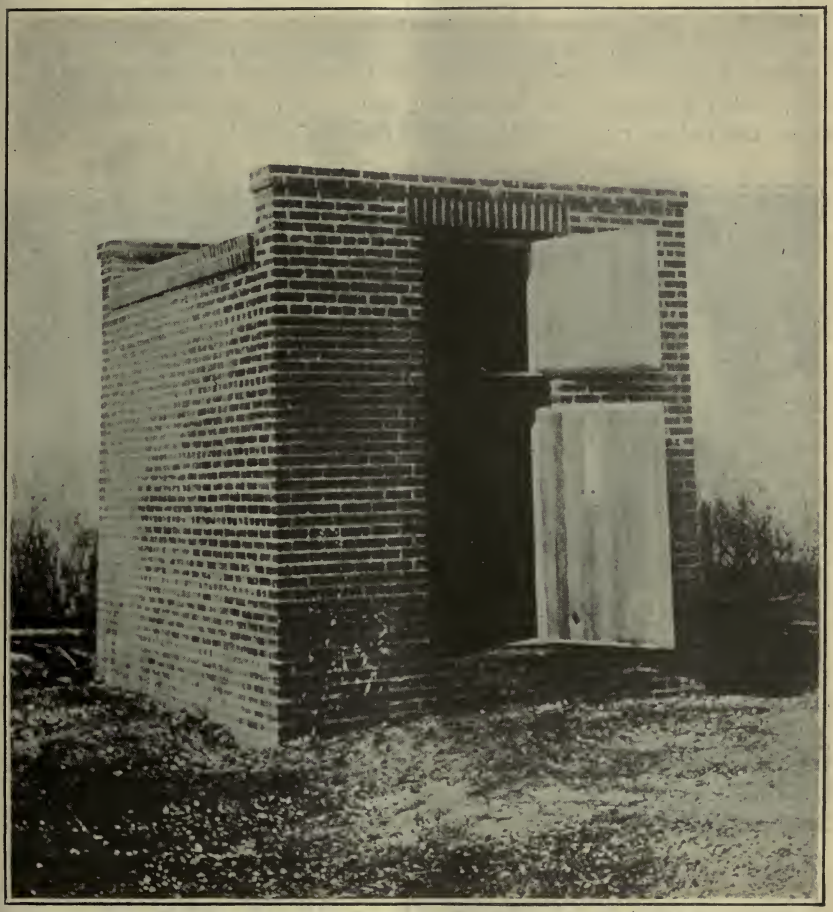

FIG. 15.—Meat curing and smoking house. (Built in Georgia after plans by United States Department of Agriculture.)

warm air and prevent overheating of the meat. Small openings under the eaves or a chimney in the roof will control ventilation. If arrangements can not be made to have a fire pit outside the house, it can be built on the floor and a metal sheet constructed to shield the meat. If the meat can be hung 6 or 7 feet above the fire, this shield will not be necessary. At this height the meat will get the benefit of the thick smoke and still hang below the ventilator.

THE FUEL.

Green hickory or maple wood is the best fuel for smoking. Hard wood is preferable to soft wood. Resinous woods should never be used, as they give an objectionable flavor to the meat. Corn cobs may be used, but they deposit carbon on the meat, giving it a dirty appearance.

SMOKING.

Meat should be removed from the brine when it is cured and not allowed to remain in the brine over time. When the meat is removed from the brine it should be soaked for about half an hour in water.

FIG. 16.—Meat hanging in the smokehouse.

If meat has remained in the brine longer than the allotted time, soak each piece half an hour and 3 minutes extra for each day over time. The meat should then be washed in lukewarm water, strung, and hung in the smokehouse. Do not hang the meat so that the pieces touch. (Fig. 16.) The space between the meat is necessary to insure good circulation of smoke around the meat. Permit the meat to hang in the smokehouse for 24 hours before beginning to smoke. A slow fire should be started, so that the meat will warm up gradually. Do not get the house too hot. The fire can be kept going continuous until the smoking is complete, holding the temperature as even as possible (120° F.). Thirty-six to 48 hours is the time required to smoke a

lot of meat, but if the meat is intended to be kept for any length of time slower and longer smoking is desirable. During warm weather it is better to start the fire every other day rather than heat up the meat too much. In the winter, however, if the fire is not kept going the meat may cool and the smoke will not penetrate properly. As soon as the meat is thoroughly smoked, open the doors and ventilator, so that the meat can cool. When the meat is smoked it can hang in the smokehouse, but for absolute safe-keeping it should be wrapped or packed away.

PRESERVING SMOKED MEATS.

Smoked meat after it is hard and firm should be wrapped in heavy paper and put into muslin sacks. It is very important that the top of the sack be tied properly so as to keep out insects. Cut the strings from the hams or bacons before they are placed in the sacks. There is a great tendency to use the same string to hang up the meat after it is sacked. It is impossible to tie the top of the sack and make it insect proof if a string sticks out of the top. In tying the top of the sack make a double wrap before tying a knot and this will prevent the entrance of any insects. Each sack should be painted with yellow wash and then each piece can be hung up for future use. Never stack the hams and bacons in a pile after yellow wash has been applied.

RECIPE FOR YELLOW WASH.

For 100 pounds hams or bacons use—

3 pounds barium sulphate.
0.06 pound glue.
0.08 pound chrome yellow.
0.40 pound flour.

Half fill a pail with water and mix in the flour, dissolving all lumps thoroughly. Dissolve the chrome yellow in a quart of water in a separate vessel and add the solution and the glue to the flour; bring the whole to a boil and add the barium sulphate slowly, stirring constantly. Make the wash the day before it is required. Stir it frequently when using, and apply with a brush.

SHIPPER'S CERTIFICATE.

Farmers who ship their cured meats must comply with official State and Federal regulations. Below appears a sample shipper's certificate such as must be used in interstate shipments of uninspected meat or meat food products which are from animals slaughtered by the farmer on the farm. In providing blank certificates for this purpose this sample should be followed. In size it should be 5½ by 8 inches.

SHIPPER'S CERTIFICATE.

*Date*_____, *191*

Name of carrier_____

Shipper_____

Point of shipment_____

Consignee_____

Destination_____

I hereby certify that the following-described uninspected meat or meat food products are from animals slaughtered by a farmer on the farm, and are offered for transportation in interstate or foreign commerce as exempted from inspection according to the act of Congress of June 30, 1906, and at this date they are sound, healthful, wholesome, and fit for human food, and contain no preservative or coloring matter or other substance prohibited by the regulations of the Secretary of Agriculture governing meat inspection.

Kind of product.	Amount.	Weight.

Two copies of this form to be presented to the common carrier with each shipment.

.....
(Signature of shipper.)

.....
(Address of shipper.)

ECONOMIC SUGGESTIONS.

Cleanliness is the most important factor in butchering and curing meats. Meat very easily becomes tainted.

Save all pieces of meat for sausage. There are many ways of converting it into a palatable product.

All waste fat, trimmings, and skin should be rendered and the product used to make soap.

Bones should be crushed or ground for chicken feed.

Never put meat in cure before the animal heat is out of it.

Always pack meat skin side down when in the curing process; except the top layer in a brine cure, which should be turned flesh side down.

Keep close watch on the brine; and if it becomes "ropy," change it.

Do not forget to turn or change meat several times during the curing process.

The fat of dry-cured meat will sometimes become yellow. This does not make it unwholesome.

It takes more time to smoke dry-cured than brine-cured pork.

Slow smoking is much better than a rapid smoking, and there is less chance of causing the meat to drip.

If meat becomes moldy, brush off the mold with a stiff brush or trim off the moldy parts with a knife. The entire piece is not spoiled.

Be sure meat is thoroughly cooled before sacking.

Remember, the seasoning of sausage is generally governed by taste.

Fresh sausage can be kept under a covering of lard for a number of days.

KEEPING FRESH MEAT.

Fresh meat is difficult to keep during the summer months without the use of ice. Even with ice very little can be handled at one time on the average farm. If a room or family refrigerator can be kept at a temperature of 40° or less, with a good circulation of air, fresh meat can be kept for a week or 10 days. The air should be dry, because moisture in a refrigerator tends to develop wet mold or slime, which will spoil the entire piece of meat. If there is an ice house on the farm, a small portion of it may be partitioned off as a cold-storage room. The ice can then be properly packed on three sides of it, and with good drainage this makes a very satisfactory place for keeping meat. This space may also be used for storing butter, poultry, or other perishable products.

A SMALL ICE HOUSE.

To keep perishable products for a considerable time, some farmers may find it convenient and necessary to build a small ice house, which is not unduly expensive and has the advantages of saving perishable products that otherwise would spoil. The following description, plans, and bill of necessary materials [1] will assist in the construction of a small ice house.

METHOD OF BUILDING THE HOUSE.

Cut four pieces of rough 2 by 6 inch scantling 4 feet 10½ inches long and spike them together in pairs to make the girders. (See A,

[1] Prepared by G. H. Parks, Meat Inspection Division of the Bureau of Animal Industry.

figs. 18, 19, 20, 21, 22.) Cut four pieces of rough 2 by 6 inch scantling 6 feet 5 inches long and set them on edge, spaced as shown in figure 19, on the girders which are to be placed at the extreme ends of the joist. The frame should now be turned over and the first layer of floor boards (marked C, figs. 18, 19, and 21) nailed to the joists. The floor boards should be cut so that they will just come to the outside edge of the joists (see C, figs. 19 and 21).

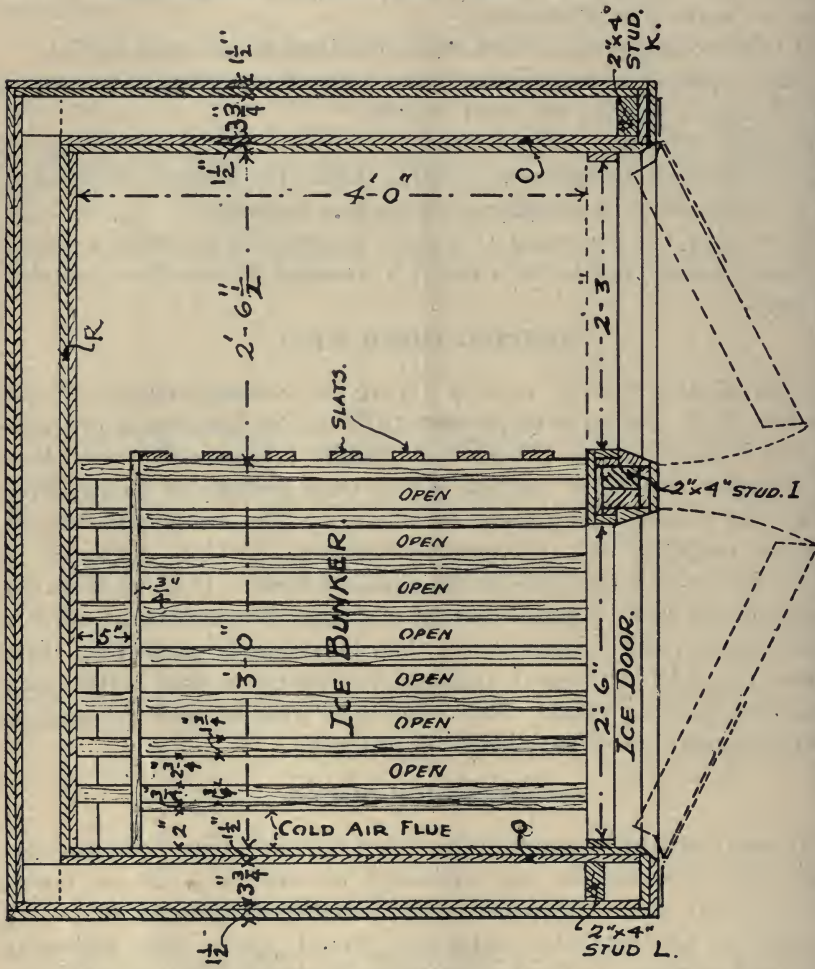

FIG. 17.—Plan for a small ice house. (Further details shown in succeeding figures.)

Over the flooring put on a layer of building paper. Cut the paper long enough to be turned up at least 4 inches on the outside face of the joists. The next layer of boards is now put on over the paper. The boards should be cut long enough to extend the thickness of the board beyond the outside face of the joists (see D, figs. 18, 19, and 21).

In figuring the drawings it is assumed that the 2 by 4's are dressed four sides, that they will measure $1\frac{3}{4}$ by $3\frac{3}{4}$ inches, and that the flooring is three-fourths inch thick.

The platform is now ready to be turned over and the ends of the girders nailed on posts which are buried in the ground about 2 feet and extend above the ground about 10 inches, so that a bucket can be placed under the drain pipe to catch the water from the melting ice and to form a trap (figs. 18 and 22).

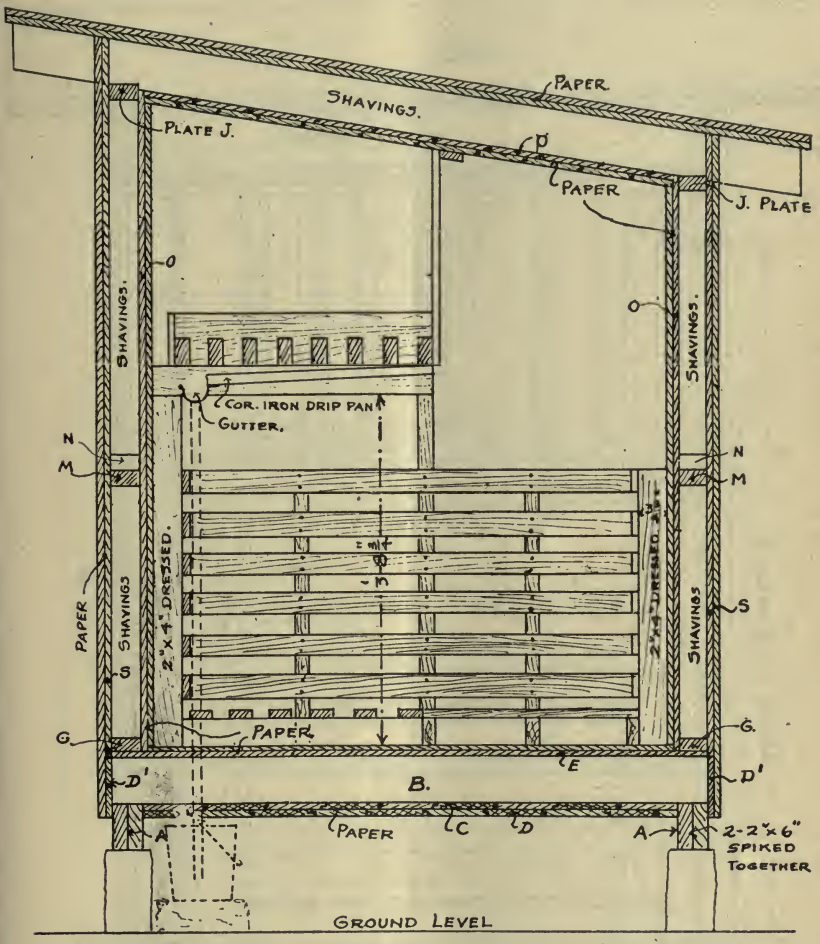

FIG. 18.—Longitudinal section of ice house.

Cut two pieces of boards 8 inches wide and 4 feet 10½ inches long and nail across the ends of the joist, placing the top edge of the board flush with the tops of the joists (see D, figs. 18 and 19). Fill the spaces formed by the joists and the end boards with dry mill shavings, using about 100 pounds.

A layer of matched and dressed boards (marked E, figs. 18, 19, 21, and 22) should now be nailed on the joists. The floor should begin

and end flush with the ends of the joists and not extend over the boards nailed to the ends of the joists (see E, figs. 18 and 21). On the long side of the platform nail a 2 by 4 laid flatwise the full length of the platform (see F, figs. 19 and 22). Across one end nail flatwise a 2 by 4 cut 4 feet 3 inches long and on the other end nail a

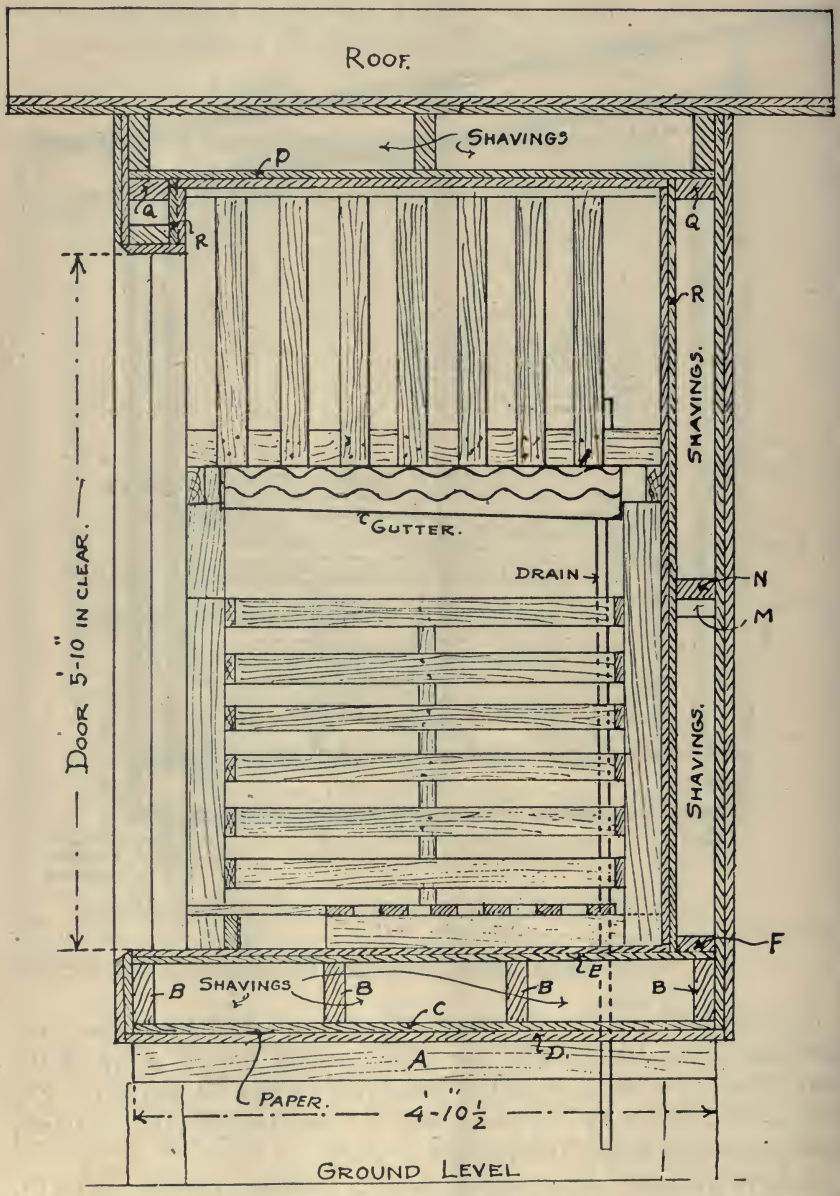

FIG. 19.—Cross section of ice house.

2 by 4 cut 4 feet 6¾ inches long, both 2 by 4's to start from the ends of the 2 by 4 marked F in figures 19 and 22. (See G, figs. 18 and 21.)

Erect a 2 by 4 stud at the end of each 2 by 4 marked G, setting the studs so that the width of the stud will be parallel with the long side of the platform. The face of stud K will be flush with the

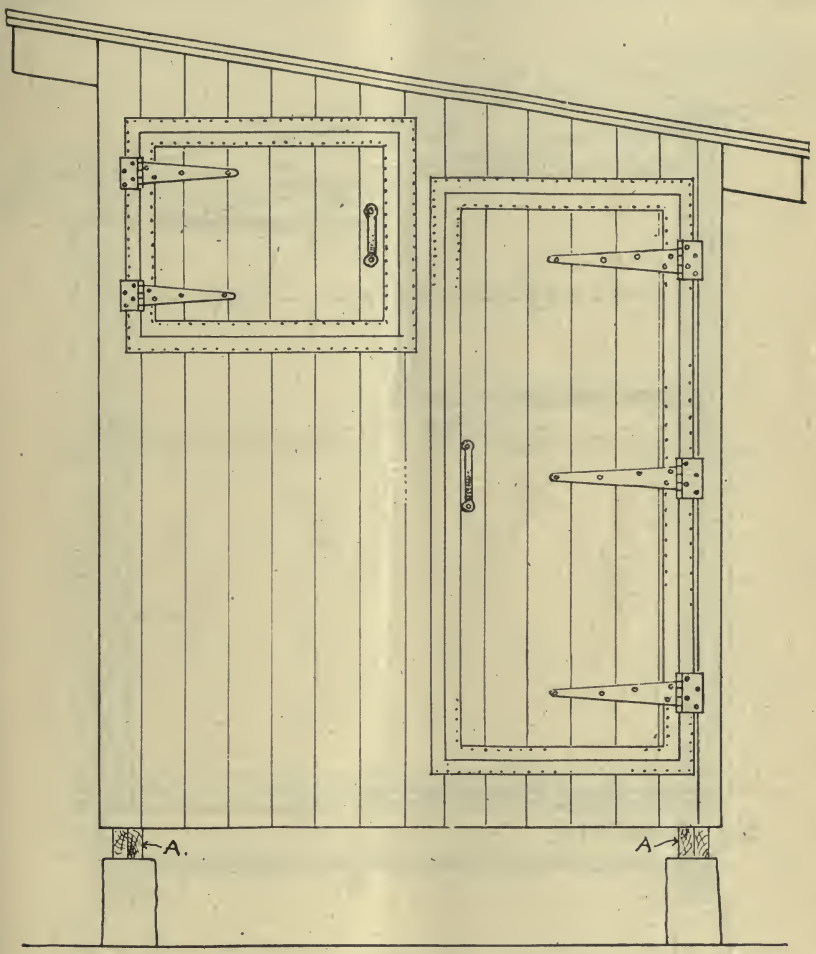

FIG. 20.—Front elevation of ice house.

outside edge of the platform, and the outside edge of stud L will be 3¾ inches back from the same face. (See figs. 17, 21, and 22.)

Cut two pieces of 2 by 4 inch 4 feet 10½ inches long for plates (plates marked J, figs. 18, 21, and 22). Cut the corner stud marked K, in figures 17 and 21, 5 feet 11 inches long and the stud marked L, in figures 17 and 21, 6 feet 11 inches long.

Now cut a 2 by 4 inch 3 feet 7½ inches long (marked H, fig. 21) and nail it along the outside edge, beginning at the outside corner of the platform. At the inside end and resting on the piece erect a 2 by 4 (marked I, figs. 17 and 21) cut to the correct height to fit under the first layer of ceiling. Cut three rafters each 8 feet 7 inches long.

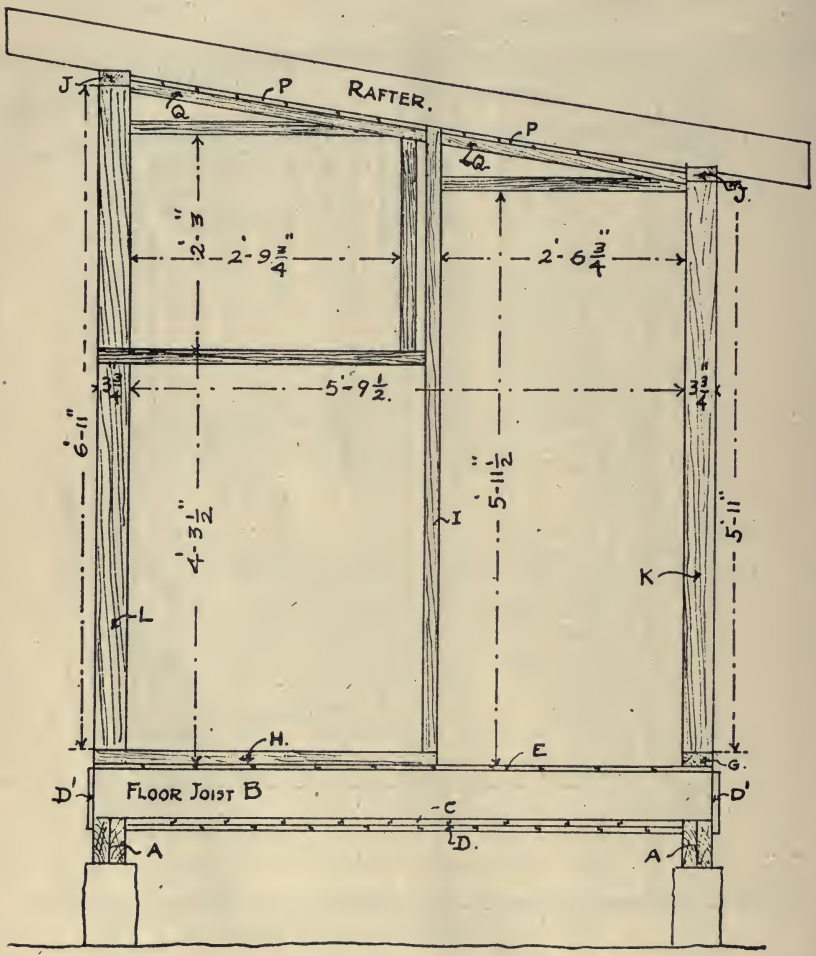

FIG. 21:—Framing of front elevation of ice house.

Nail one of the plates on top of the corner stud K, level it, and support it at the other end by a board placed upright, nail to the platform on the end and at the corner. Place the plate on the stud L, letting it project over the stud 3¾ inches, and support the opposite end by a board erected in the same way as that used to hold up the first plate.

At each end of the building, 3 feet 6 inches from the floor, put in a piece of 2 by 4 (marked M in figs. 18 and 22) set flatwise, and nail to the upright 2 by 4 and to the upright board. Next cut a piece of 2 by 4 6 feet 5 inches long (marked N in figs. 18, 19, and 22) and lay it on the end 2 by 4's (marked M) and nail them together.

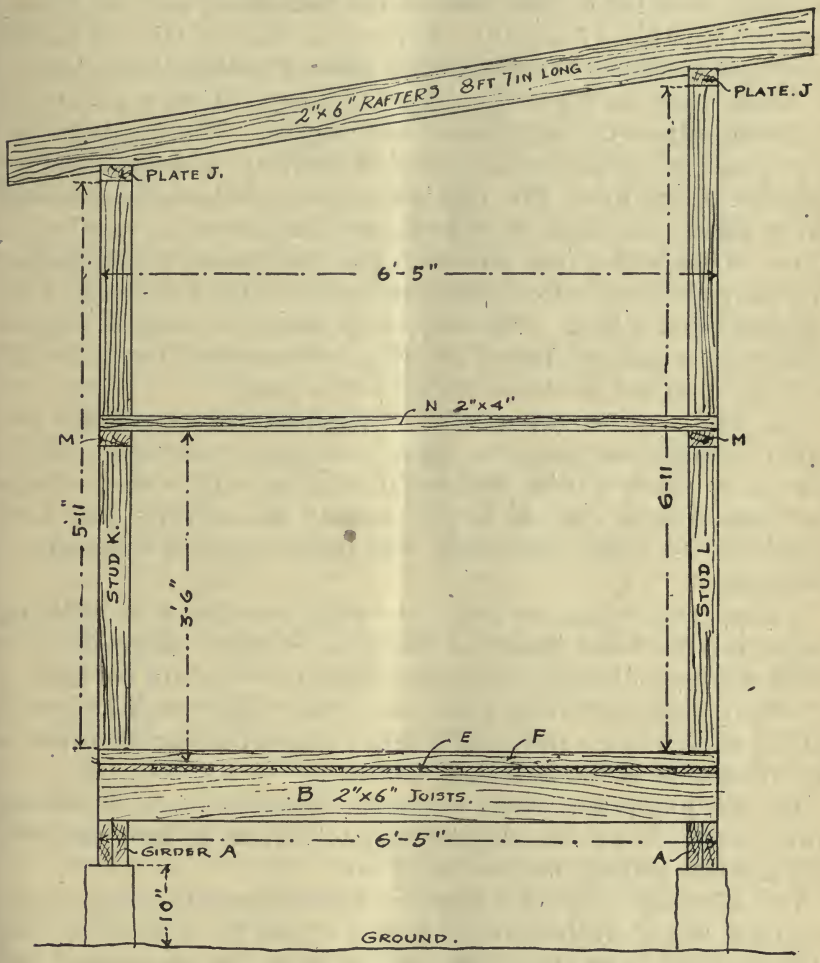

FIG. 22.—Elevation of frame of ice house.

The boards marked O in figures 17 and 18, forming the first layer of the inside lining, should now be put on the ends. The boards are cut just long enough to extend from the floor to the top of the plate. Cut three rafters 2 inches by 6 inches by 8 feet 7 inches and nail to the plates, spaced as shown in figure 18. The frame is now ready to put on the first layer of boards to form the ceiling. The ceiling

boards (marked P in figs. 18 and 19) are cut just long enough to reach between the outside faces of the rafters.

A 2 by 4 (marked Q in figs. 19 and 21) is now to be nailed flatwise to the ceiling. The inside edge of the 2 by 4 is set on a line with the 2 by 4's already in place and is for the purpose of forming a support to which the upper ends of the side boards are nailed. After this scantling is nailed in place put on the first inside layer of boards (marked R in figs. 17 and 19). Next put on the first layer of boards forming the outside. The boards for ends of building should be cut to extend from the top of the rafters to the top of the board nailed across the ends of the floor joists (see S, fig. 18). The boards for the side should be cut flush with the top of the rafter and should follow the slope of the roof. The roof is now ready to have the shavings put in place. Use about 100 pounds and then put on the roof boards in two layers with paper between. The roof boards should project over the ends of the rafter about 2 inches and beyond the sides of the building about 1 foot. The roof boards should be covered without delay with whatever kind of covering it is intended to use, as the shavings must not be allowed to get wet or damp.

The roof may be covered with tin, shingles, or one of the prepared roofings, and should be made thoroughly watertight. When putting up the first layer of the boards on the outside of the frame the corner boards can not be put on until the shavings have been packed in the walls. The walls will require about 400 pounds of shavings.

Before the shavings are put in the walls the side of the building containing the doors should be framed as shown in figure 21, then the first layers of boards put on the inside and outside of the wall.

After the shavings are in place put on the corner boards and cover all the walls with a waterproof building paper, lapping the paper at the corners and at the horizontal courses.

The building is now ready to receive the outside layer of boards, which should be put on without delay to prevent as far as possible any moisture getting into the insulation.

The doorways are beveled to receive the doors and to assist in making them fit tightly (see drawing, figs. 17 and 18). After the outside boarding is on, the inside of the room can be papered and sheathed. The paper is put on as follows: Cover the floor with two layers of waterproof paper and turn up on the walls 1 foot all around; then, starting at the floor, lay a course of paper on the walls parallel with the floor. Cut the strip 2 feet longer than the length of the wall and start the paper 1 foot from the corner, then carry around the nearest corner, tack to the wall, and carry around the next corner, doubling the paper at the corners. Put on the next course and lap over the lower course about 4 inches. Put on the remaining courses

until the ceiling is reached, when the paper should be turned over and nailed to the ceiling so that the paper covers the corner between the ceiling and the wall. Now lay the ceiling and bring down on the walls about 1 foot. Use care in putting on the paper so that no holes will be punched in it. After the paper is on lay the top floor and ceiling before putting on the side and end walls, using care to make as tight a fit as possible between the floor and walls and the ceiling and walls.

After the walls are finished build the ice crib. The floor of the ice crib is made of 2 by 4 dressed longleaf yellow pine, spaced 2¾ inches apart. The supports for the floor are made by nailing a piece of dressed 2 by 4 inch scantling parallel with the floor to the inside boarding of the house and under each end of the scantling is nailed a 2 by 4 extending from the floor of the house to the underside of the supports. Running across the box nail a piece of 1 by 3 inch flatwise on the ceiling. The strip is so placed that it will be outside of the ice crib and to it are nailed 1 by 3 inch dressed slats spaced about 3 inches apart. The bottom of the slats are nailed to the outside of the first joist of the ice crib. This joist is located 3 feet from the back of the ice crib.

The joist nearest the back of the ice crib is spaced 2¾ inches from the back wall. On the face of this joist between the joist and the wall, nail a strip 1 by 4 inch dressed, letting the strip project 2 inches above the top of the joists. Five inches from the inside end of the ice crib nail a 1 by 4 inch dressed strip across all the joists to form a stop for the ice cakes.

The drip pan under the ice crib is made of a sheet of galvanized corrugated iron. The corrugations run the long way of the room. The sheet is made 2 feet 7 inches wide and 3 feet 4 inches long, the width being the length of the corrugations. A 3-inch galvanized iron gutter 3 feet 4 inches long is riveted to the edge of the sheet on the underside. The sheet should pitch about 2 inches in the width. The high end of the sheet is nailed to the bottom of the first joist and the low end is supported by three straps soldered to the gutter and nailed to the joist above. The gutter should be closed at each end and should pitch about an inch from the front to the back. At the lowest point of the gutter the drain pipe should be attached by soldering. The drain pipe is a piece of gas or water pipe ¾-inch inside diameter and should extend from the gutter through the floor of the house and project below about 12 inches. If a bucket is so placed under the pipe that the bottom of the pipe will be about an inch from the bottom of the bucket, the water from the melting ice will form a water seal that will prevent the outside air from entering the house. At least 2 inches of water should be kept in the bucket to form the seal.

If a drain is provided to carry away the water, the bucket can be omitted, provided a trap is made in the pipe.

The meat should not be stacked on the floor of the building, but racks should be provided. The racks are made by nailing 2 by 4's edgewise against the wall and on the floor. On the face of the 2 by 4's strips 1 by 3 inches spaced about 3 inches apart are securely nailed.

The racks on the floor should not be nailed to the floor, but should be made removable in order to facilitate cleaning.

The racks against the walls are for the purpose of permitting the air to circulate around the meat.

The doors are made of three thicknesses of boards similar to those used in lining the room, nailed to a frame made of dressed 2 by 3's. The frame is first made and covered with a thickness of boards. The box thus formed is filled with shavings and covered with boards. Turn the door over, lay a sheet of paper on the boards, and add another thickness of boards. The edges of the door are to be beveled to fit the door opening. The door must be made smaller than the opening to allow for the canvas and felt that are to be nailed all around the edges of the door and around the door opening. The hinges to hang the door should be extra heavy T hinges. The outside of the building should be painted three coats with an oil paint. The efficiency of the house depends upon the tightness with which it is built, and to assist in keeping it tight it is necessary to paint the outside to keep moisture out of the boards, which would cause them to swell and pull away from the inner boards. The paint will also help to keep the boards from the shrinking caused by heat from the sun. The inside of the building should be shellacked or varnished with a waterproof varnish. The varnish will keep the boards from absorbing moisture and causing trouble and will also permit the house to be easily cleaned. The house should be thoroughly cleaned immediately after the meat has been removed.

BILL OF MATERIALS.

FRAME.

2 pieces 2 by 6 inches, 10 feet long, for girders, rough.
2 pieces 2 by 6 inches, 14 feet long, for joists, rough.
3 pieces 2 by 6 inches, 9 feet long, for rafters, rough.
2 cedar posts, 6-inch diameter, 6 feet long.
1 piece 2 by 4 inches, 6 feet long, stud K, dressed.
1 piece 2 by 4 inches, 7 feet long, stud L, dressed.
1 piece 2 by 4 inches, 7 feet long, stud I, dressed.
3 pieces 2 by 4 inches, 10 feet long, for plates and pieces G and M, dressed.
3 pieces 2 by 4 inches, 14 feet long, for pieces F, H, M, Q and framing for doors, dressed.
800 feet b. m. tongued and grooved flooring, dressed.

25 linear feet 1 by 3 inches, for door stop, dressed.
1 piece, 2 by 4 inches, 10 feet long, for beveled jamb of doors, dressed.
2 pieces 2 by 3 inches, 14 feet long, for frame of doors, dressed.

ICE BUNKERS.

1 piece 2 by 4 inches, 6 feet long, for supports, dressed.
7 pieces 2 by 4 inches, 4 feet long, for floor beams, dressed.
1 piece 1 by 4 inches, 8 feet long, for ice stop, dressed.

FLOOR AND WALL RACKS.

3 pieces 2 by 4 inches, 7 feet long, for walls, dressed.
2 pieces 2 by 4 inches, 10 feet long, for floor, dressed.
9 pieces 1 by 3 inches, 14 feet long, slats for ice bunker and wall and floor racks, dressed.

HARDWARE, ETC.

3 extra-heavy T hinges, 18 inches long and screws.
1 pair extra-heavy T hinges, 12 inches long and screws.
1 pair 6-inch handles and screws.
25 pounds 6-penny flooring nails, wire.
5 pounds 10-penny wire nails, common.
5 ounces of 3-ounce tacks.
1 sheet corrugated galvanized iron, 2 feet 6 inches by 4 feet.
1 piece 3-inch galvanized iron gutter, 3 feet 4 inches long, with 3 straps ¾-inch wide by 8 inches long, to fasten gutter to ice floor.
1 piece ¾-inch gas pipe, galvanized, 4 feet 6 inches long.
24 yards canvas or heavy duck, 9 inches wide.
20 yards felt, 6 inches wide, for padding under canvas.
2 gallons waterproof varnish.
2 gallons lead and oil paint.
400 square feet of insulating paper.
70 square feet roofing paper with nails and pitch.
600 pounds dry mill shavings.

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CONTROL OF THE MELON APHIS

(ATTACKS CUCUMBERS, MELONS, OTHER CUCURBITS, COTTON, ORANGES, ETC.)

F. H. CHITTENDEN

Entomologist in Charge of Truck Crop Insect Investigations

Lifting vines for underspraying against the melon aphis

FARMERS' BULLETIN 914

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology

L. O. HOWARD, Chief

Washington, D. C. February, 1918

Show this bulletin to a neighbor. Additional copies may be obtained free from the Division of Publications, United States Department of Agriculture

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

NEXT to the striped cucumber beetle the melon aphis, or "melon louse," is our most important cucumber insect pest and probably the most serious enemy of melons and related crops in this country. It works quickly, sucking the juices of the plants and causing them to wither and die, often before insect injury is suspected. Large fields often are destroyed in a few days.

This insect is minute, of some shade of green, from pale to nearly black, and in its younger stages is louselike in appearance. When numerous the melon "lice" develop wings and fly to various crops and are likely to be found first on cotton, okra, orange, and related plants, and on weeds.

Although, fortunately for us, the melon aphis has more than 40 insect enemies which hold it in check in many regions much of the time, artificial control becomes imperative when weather conditions are unfavorable to its parasites.

This bulletin describes several methods of control, the most important of which is spraying with nicotine sulphate, as described on pages 11 and 12. Keep a constant lookout for first signs of injury and employ control measures promptly on the appearance of the insect; otherwise the entire crop may be lost. Be careful to select the best spraying devices appropriate for work against this pest, as described on pages 13 and 14.

CONTROL OF THE MELON APHIS.

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NATURE OF ATTACK.

THE MELON APHIS,[1] or, as it is commonly known, "melon louse," injures plants by piercing them with its beak and sapping their vitality. It occurs from early spring to late autumn on cantaloupes and other melons, cucumbers and other cucurbits, and on many other crop plants, and in seasons which favor its increase, notably in summers following springs that are cool and rainy, it frequently develops in enormous numbers and does very serious damage, collecting in masses on the under surface of the leaves of plants and causing them to curl, shrivel, and lose color, and interfering with the ultimate development of the fruit. Often it kills plants outright and destroys whole fields or reduces greatly the yield of fruit. An affected cantaloupe plant is shown in figure 1.

The melon aphis, like others of its kind, excretes "honeydew," but not so copiously as most injurious plant-lice; for example, certain forms which affect trees. When the melon aphis becomes unusually abundant, however, the honeydew covers the leaves of the affected plants with a thin, sticky coating to which the white molted skins of the insects adhere, and this attracts attention to injury, as does also the wilting and dying down of the plants. Many persons who notice the honeydew are unaware of the presence of the insects. They speak of the injury as "honeydew," and have even applied this name to the insect itself.[2]

[1] *Aphis gossypii* Glover; suborder Homoptera, family Aphididae.

[2] Attack by many forms of plant-lice, especially those which excrete honeydew more copiously than others, can be detected readily by the presence of insects which feed on the sweet excretion. Among these are flies, wasps, bees, and especially ants. The melon aphis, however, is not an especial favorite with ants, although some common species are occasionally found in attendance upon it.

Too frequently it happens that by the time the presence of the melon aphis in injurious numbers is noticed irreparable damage has been accomplished and the insects for the most part have migrated to other pastures. It is advisable, therefore, that remedial measures be undertaken *before* the aphis injury becomes conspicuous.

DESCRIPTION.

The melon aphis (fig. 2) is a minute, soft-bodied creature of sluggish habit and variable color, usually some shade of green or greenish black, and in its young and wingless stages louselike in appearance. The egg is regularly oval and about one-fortieth of an inch in length, yellowish or greenish when first deposited, but soon changing to jet black. The young aphis, or nymph (fig. 2, *b*), when first born or hatched is less than one-fiftieth of an inch in length and nearly colorless, but later it turns yellowish. The last nymphal stage, corresponding to the pupa or cocoon stage of other insects, although not inactive, is shown at *c* in figure 2, and the adult wingless female which reproduces by giving birth to living young is shown at *d*. The body color of the adult insect varies from pale yellow to very dark green. The nectaries, or honey tubes, are black and the antennæ and legs yellowish white. The wingless female is from one-sixteenth to one-fourteenth of an inch long. The winged female is

FIG. 1.—Cantaloupe leaves showing curling caused by the melon aphis; insects in view on lower surface and on tendril.

shown in figure 2 at *a*. In this form the body is more slender than in the wingless form, and the length is from one-twentieth to one-fourteenth of an inch. A darker form of the female is shown in profile at *ab* in figure 2, and one of the antennæ, or feelers, greatly enlarged, at *aa*. The male of this species has not yet been described.

ECONOMIC IMPORTANCE.

The melon aphis is by far the most abundant and destructive aphis affecting cucumbers, melons, and other cucurbits, and is not likely

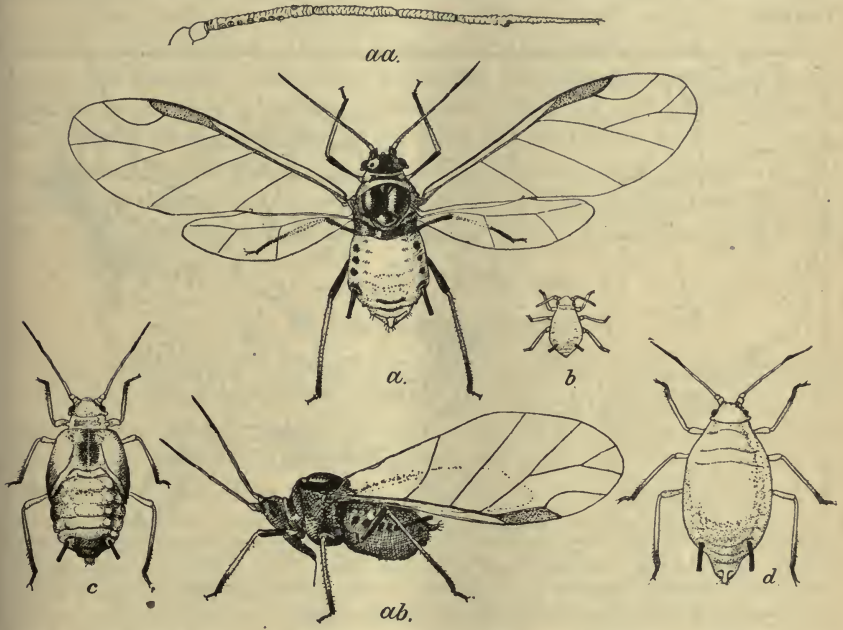

FIG. 2.—The melon aphis: *a*, Winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view; *b*, young nymph; *c*, last stage of nymph; *d*, wingless female. All enlarged greatly.

to be confused with any other species occurring habitually on the same class of plants.[1] It is, indeed, a pest of the highest importance and, taken season after season, the most destructive aphis occurring in this country. The records of the Bureau of Entomology show that the complaints of injury are only one-third less in number than of the striped cucumber beetle, indicating that this aphis ranks at least second as a cucumber and melon pest.

As an instance of the damage done by the melon aphis in a single year, a pickle company at Omaha, Nebr., reported a loss of between

[1] The squash aphis (*Macrosiphum cucurbitae* Middleton), a much larger species and more uniformly lighter and brighter green, attacks cucurbits, but seldom in sufficient numbers to cause noticeable damage.

30,000 and 50,000 bushels of cucumbers, and one company in Texas estimated their loss at fully $20,000.

DISTRIBUTION.

The original home of the melon aphis is doubtful, but it is probably in the Tropics, as this insect shows a decided preference for plants of a tropical nature such as the cucurbits, cotton, and orange. Southward this aphis occurs in the West Indies, Mexico, and Brazil, and doubtless elsewhere in South America. It occurs injuriously also in the Hawaiian Islands, South Australia, South Africa, and the East Indies.

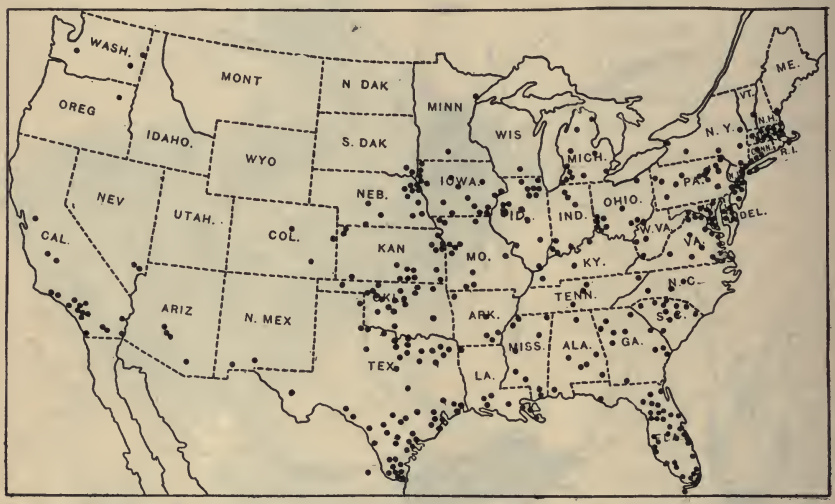

FIG. 3.—Map showing localities from which the melon aphis (*Aphis goscypii*) has been reported. Includes records up to March 20, 1917. The insect probably is present throughout the regions in which the dots are numerous.

It is very generally distributed throughout the United States (see fig. 3), and frequently is reported as doing more injury in the Southwest than elsewhere, although a serious pest in the Gulf region. In Texas, Kansas, and Nebraska it is particularly troublesome to melons, and, in the last two States, to cucumbers, which are extensively grown for pickling. At any time, however, it may create more or less trouble in northern and eastern regions, particularly in Maryland, Virginia, Delaware, and New Jersey, where cucurbits are much cultivated. Occasionally it is injurious as far north as Minnesota and as far west as California.

SEASONAL HISTORY.

Damage to cultivated plants begins in early spring or later, depending upon locality and climate, and continues for some time.

It is caused by the winged individuals which fly from weeds and other vegetation serving as their other food plants. Infestation naturally commences earlier in the South than northward and may occur simultaneously with the appearance of the crop above ground. Soon after the plants have developed leaves a few winged plant-lice usually can be found, and these are the forerunners of the myriads which follow. As often as a plant becomes exhausted of its vital juices by the sucking of innumerable plant-lice, winged individuals are developed which fly to other plants, so that migration of the species is going on throughout practically the entire season.

Flight from one kind of food plant to another, or from one field to another, is due to atmospheric conditions, such as wind and rain, and to the abundant natural enemies of the insect. The great numbers of this species sometimes suddenly discovered on melons, cotton, orange, and other plants are often the result of enforced migration on account of the death of other food plants in the vicinity, such as might be caused by weather conditions or by the ravages of the plant-lice themselves or of other insects. The removal of the crop on which the insect has been working would have the same result.

FOOD PLANTS.

PREFERRED FOOD PLANTS.

The melon aphis is partial to the cantaloupe and other melons, cucumber, pumpkin, wild gourd, winter squash, and other cucurbits, cotton, okra, and orange and other citrus fruits, these being natural food plants on which the insects feed and multiply. When the cucurbits, cotton, and okra die down, the melon "lice" which have been feeding on them may migrate to citrus trees, which thus become, for these individuals, second-choice food plants. The other plants which have been attacked and on which the insect often is found colonized are probably second-choice food plants, since records do not show that the insect breeds upon these plants continuously. Perhaps this is not the case with certain plants grown in greenhouses, since the melon aphis has been found very commonly on greenhouse violets.

From the abundance of this insect on the favorite food plants recorded above, it has received a number of common as well as Latin names, the former including "cotton louse," "orange louse," "cucumber louse," and "cantaloupe louse." In greenhouses it is frequently known as the "green aphis" to distinguish it from lighter hued kinds and from forms such as the brown violet aphis.[1]

OTHER FOOD PLANTS.

The following list includes what are apparently in the main either second-choice food plants, or plants on which the insect usually will not feed when cucurbits are near by: Hops, strawberry, beans.

[1] *Rhopalosiphum violae* Pergande.

sugar and table beets, spinach, tomatoes, asparagus, and several ornamental plants, including the hydrangea, begonia, ground ivy, acalypha, and morning-glory. It is also recorded as feeding on such common weeds as shepherd's-purse, peppergrass, great ragweed, dock, fleabane, milkweed, burdock, dandelion, lamb's-quarters, plantain, chickweed, and mallow. In the absence of their favorite food plants the winged forms are likely to start colonies on any of these or other plants which happen to be in the line of flight.

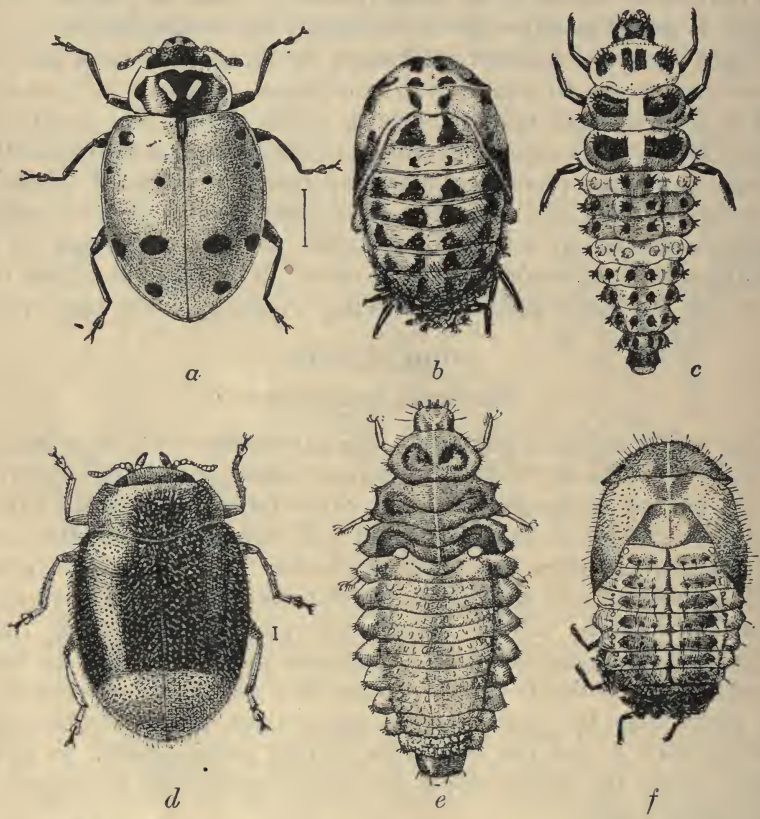

FIG. 4.—Useful ladybirds which prey upon the melon aphis and other plant-lice: *a*, Adult of convergent ladybird (*Hippodamia convergens*); *b*, pupa of same; *c*, larva of same; *d*, adult of *Scymnus terminatus*; *e*, larva of same; *f*, pupa of same. All greatly enlarged. Size indicated by hair lines at right of adults.

NATURAL ENEMIES.

There is perhaps no better example among insects of a common and widespread species held in abeyance and limited to innoxious numbers, save in exceptional seasons, by natural enemies, than the melon aphis. The usefulness of these natural enemies, of which a large number have been recorded, in subduing the plant-lice can not be overestimated. Garden and field plant-lice generally are subject to attack by the same classes of parasitic and predacious enemies. The

number of insect species known to prey upon the melon aphis is about 40. The list includes many ladybirds, or "ladybugs," which destroy the plant-lice both as adults and as larvæ; the maggots of certain syrphus-flies, which consume large numbers of plant-lice; and aphis lions, which are the larvæ of lacewing flies. A number of species of minute parasitic, four-winged, wasplike insects are very important checks on the increase of plant-lice. Parasitic fungi also destroy many.

The insect enemies of these, as of other plant-lice, keep their hosts, in many portions of the country and in ordinary seasons, in nearly complete subjection. The parasites, in particular, are most effective in dry, warm weather. In cooler, moist summer weather, *especially when this follows the same atmospheric conditions in spring*, these otherwise natural checks are less active, and the plant-lice, as a result, frequently gain the ascendency.

Two common species of ladybird enemies of this and other plant-lice are illustrated in figure 4. The most abundant and useful form of this class of insects is the convergent ladybird, shown at *a*, *b*, and *c*.

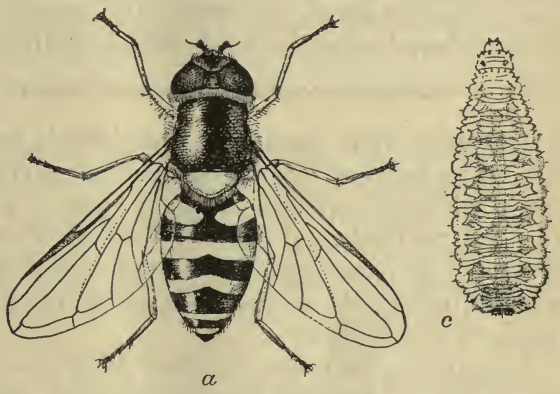

FIG. 5.—A syrphus-fly (*Syrphus ribesii*) which is an enemy of the melon aphis: *a*, Adult fly; *c*, larva or immature form. Much enlarged.

Curiously enough, this is frequently mistaken for the parent of the plant-lice. Another very efficient enemy is shown in figure 4, *d*, *e*, *f*. One of the most abundant syrphus-fly enemies is illustrated in figure 5.

Of the natural enemies which have been enumerated, ladybirds are particularly valuable, owing principally to the fact that they are active at all seasons, especially *at the outset of aphis attack.*

Parasites are most effective toward the end of the season, when they often reduce the plant-lice so that few are left to hibernate and produce other generations of the pest the following year.

The value of these natural enemies against plant-lice is such that entomologists frequently advise the employment of remedies only when the enemies are not present in abundance. The ladybirds and some other hardy beneficial insects, which are practically always present on infested vines, often survive spraying and continue action thereafter.

METHODS OF CONTROL.

VALUE OF FREQUENT INSPECTIONS AND EARLY WORK.

Severe losses by this species can be largely reduced[1] *and in many cases actually prevented by the employment of control measures upon the first appearance of the insect.*

It should be borne in mind that the plant-lice attack first the underside of the leaves, and if injury is to be averted they must be combatted before the leaves have become crinkled and wilted and their upper surface covered with honeydew. (See fig. 1.) Manifestation of injury usually begins by the time the runners are a foot in length but varies with temperature and locality.

The vines should be inspected at least twice a week, not alone in one part of the field but in several, as the insect is sometimes abundant in certain areas, or "spots," and scarce in others, and from the badly infested areas the whole field is likely to be overspread.

GENERAL CONSIDERATIONS WITH REGARD TO SPRAYING.

The melon aphis would not be a difficult species to control were it not for its habit of feeding on the lower surface of the leaves, which are often badly curled as shown in figure 1, and for the further fact that in large fields, and especially late in the season, the leaves become large and the vines spread and grow closely together, frequently becoming interlaced, so that effective spraying by ordinary means is rendered impracticable.

Failure is sometimes reported from the use of such approved remedies as 40 per cent nicotine sulphate. In such cases the ineffectiveness of the spray is due nearly always to the use of the wrong formula, incorrect preparation, or careless application. The relative proportions of the ingredients should be maintained throughout the spraying.

In the use of any of the contact insecticides mentioned in this publication it should be remembered that their value is in direct proportion to the thoroughness of their distribution. None of them is effective unless brought into contact with the bodies of the insects. The undersides of the sprayed leaves should be examined from time to time, to see that they are being wetted, and this may be used as an index to the effectiveness of the spray. *The plant-lice will not be destroyed unless brought into direct contact with the spray.*

Insecticides are often applied to plants which already have been so checked in growth from aphis feeding that recovery is impossible. In these cases, obviously, the spraying can not be condemned as inefficient.

[1] It has not always been found possible wholly to prevent injury to young and tender plants, particularly cucumbers grown for pickling.

Hot, dry winds or a combination of cold weather and drought are likely to retard the growth of the plants and in years when plant-lice are abundant the unthriftiness of the plants may be due more largely to these untoward weather conditions than to the plant-lice. If this is the case, spraying, of course, will have little effect.

Unlike the large forms of sucking bugs which derive their food by the same method, as, for example, the harlequin cabbage bug[1] and the squash bugs,[2] all stages of plant-lice from the smallest nymph to the adult are equally susceptible to insecticides.[3]

SPRAYING WITH NICOTINE SULPHATE.

As a spray for the melon aphis and other plant-lice, nicotine sulphate thus far has given the best results. Tobacco in different forms has been used with success, chiefly in the vaporization of greenhouses, since about 1894. It has been used to a considerable extent in later years for this purpose, and also to some extent in the field, but is being superseded by nicotine sulphate sprays and nicotine fumigating papers.

In later years it has been found that a solution of nicotine sulphate standardized to contain 40 per cent by weight of nicotine has given the best results. It has been tested practically wherever melons and other cucurbits are grown on a large scale, but especially in California, Illinois, Florida, Oklahoma, Texas, and several other States, both by representatives of the Bureau of Entomology and by State entomologists and practical workers. It was used on one occasion at Turlock, Cal., on 800 acres of watermelons and cantaloupes with excellent results.

While 40 per cent nicotine sulphate is recommended for the melon aphis, careful application is required as in the case of all other insecticides.

Nicotine sulphate is used according to what is known as the 1–1,000 formula, or 1 part of 40 per cent nicotine sulphate to 1,000 parts of water. To this mixture should be added sufficient soap or similar spray material to act as a "spreader." Common laundry soap is cheap, easily obtainable, and satisfactory for the purpose. The amount required may be estimated on the basis of 1 pound to each 25 gallons of the mixture.

The following formula will be found to combine the ingredients in the proper proportions:

Nicotine sulphate, 40 per cent	fluid ounces	3
Yellow laundry soap	avoirdupois pound	1
Water	gallons	25

[1] *Murgantia histrionica* Hahn.

[2] *Anasa* spp.

[3] In the case of the large sucking bugs, the last two stages are very difficult to destroy with any form of contact or other insecticide.

On account of the low, spreading nature of the vine growth a much more even distribution of the spray is effected by a power sprayer than by a hand-operated machine. Such a sprayer may be equipped with four lines of hose, each fitted with a spray rod and one or more wide-angle nozzles provided with elbows. With this outfit four men may spray at one time, each man having a spray rod and covering a separate row of vines. For spraying vines grown in hills a hand sprayer is generally used. See "spraying machinery and appliances," pages 13 and 14.

SPRAYING WITH SOAPS.

Soaps of nearly every kind are valuable as sprays for the control of the melon aphis and others of its kind. Both hard and soft soaps, manufactured from fish oil, are much employed.

For use on the melon aphis about 8 pounds of soap to 50 gallons of water will make an emulsion of sufficient strength, but it may be used a little weaker or, if necessary, considerably stronger without injury to the plants. This will destroy not only the melon aphis but any minute leaf-bugs, thrips, or other insects which happen to be present.

Soaps possess no particular value over kerosene-soap emulsion, but they are more readily prepared. Special fish-oil soaps which are combined with tobacco or resin are used on field crops, and soaps combined with naphtha, cresol, and distillates.

For use in greenhouses neutral soaps of the castile and physicians' and surgeons' type are much used, both for the control of this insect and for the red spider, thrips, and other minute, soft-bodied pests.

Soap sprays are applied in the same manner as nicotine sulphate spray.

SPRAYING WITH KEROSENE EMULSION.

Kerosene-soap emulsion, a standard remedy for sucking insects such as plant-lice, is of secondary value to the nicotine sulphate solutions, and is prepared by combining 2 gallons of kerosene and one-half pound of fish-oil soap or 1 quart of soft soap with 1 gallon of water. The soap is dissolved in boiling water and then poured while still boiling hot (away from the fire) into the kerosene. The mixture is then churned rapidly for about five minutes, the liquid being pumped back upon itself by means of a force pump and direct-discharge nozzle throwing a strong stream. At the end of this time the mixture will have become of the consistency of cream. Properly prepared an emulsion will keep almost indefinitely, and should be diluted only as needed for use. For most kinds of plant-lice the staple emulsion should be diluted with from 10 to 20 parts of water.

In the preparation of kerosene emulsion a force pump is a necessity, since if not made according to directions a perfect emulsion will not

be formed. There is then danger of injury to the plants by the kerosene, as also useless waste. There is danger and waste, too, if the insecticide is not applied by means of a fine nozzle in the form of a spray, which should be fine and mist-like, or "like a fog," as some one has aptly expressed it. It should be sprayed only for a long enough time to cover the plants, otherwise the liquid will form into globules and run off. Figure 6 illustrates the method of operating a compressed-air sprayer so as to produce an underspraying. In the case of the cucumber, more thorough work can be done by two men than by one, as shown in the title-page illustration, in which the man on the left is holding up the vine so that the man on the right can spray thoroughly the lower surface of the leaves. By this method a single spraying frequently will suffice.

FIG. 6.—Method of underspraying cucumbers with compressed-air type of sprayer.

SPRINKLING OR SPRAYING WITH WATER.

Where a few plants only are infested, and it is possible to direct a strong stream of water upon them from a garden hose, syringe, or spraying machine, so as to wash off the insects, this aphis can be materially checked without the use of other substances. Those insects that come into direct contact with a stiff spray of water are unable to survive, while others that are dislodged from the plants do not succeed in returning. Many are wingless during the greater part of the season and are unable to crawl any distance, particularly if the ground be dry and hot.

SPRAYING MACHINERY AND APPLIANCES.

Various types of spraying machinery may be employed, but for spraying cucumbers a hand sprayer is much used. (See fig. 6 and title-page illustration.) This should be fitted with a spray rod having an upturned elbow and a nozzle of the vermorel or eddy chamber (fig. 7) type, so that the spray may reach the underside of the leaves.

In large commercial plantings of melons the amount of hand labor required in spraying with small compressed-air sprayers becomes somewhat costly, and a traction or gasoline power sprayer is preferable. The type ordinarily used is a traction machine, operated by one or two horses, a practical form of which is illustrated in figure 8. The nozzles are so arranged as to work close to the tops of the plants, and one to three rows may treated at one time, especially while the vines are young. A pressure of about 150 pounds may be developed and with the close placing of the nozzles this pressure moves the leaves about in such a manner that both the under and upper surfaces become thoroughly wet by the spray.

A sprayer of the type manufactured by at least one company in the United States, although designed especially for work with onions, is

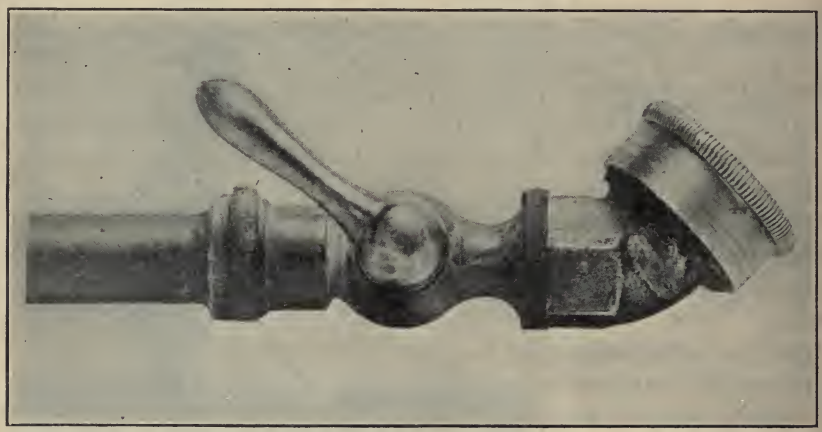

FIG. 7.—Angle disk nozzle for underspraying.

applicable for such crops as melons as well. In this sprayer, which is of the large gasoline-power type and is so arranged as to draw a 250-gallon tank by means of horses, two long arms of $\frac{3}{4}$-inch pipe, each about 35 feet long and supported by a steel wire truss, are used. To the ends of these pipes are attached two 25-foot lengths of hose, each length being fitted with a 15-foot extension rod equipped with an angle or elbow and a pair of nozzles. With such an apparatus a space 100 feet wide can be sprayed readily by three men, one to act as driver and engineer and the other two to handle the nozzles. The pressure available through the power equipment secures an unusually thorough distribution of the spray with resultant destruction of the plant-lice. The arms of pipe leading to the hose are fitted on swivel connections, so that while the sprayer remains standing an area approximately 100 feet square can be sprayed. This necessitates turning the vines into the rows on a comparatively small portion of the field.

CARBON DISULPHID FUMIGATION.[1]

The carbon-disulphid treatment of the melon aphis has been employed successfully for some time and is valuable in small fields, but less profitable where cucurbit or other crops are grown over large areas. It consists in evaporating carbon disulphid (known also as carbon bisulphid, bisulphide of carbon, etc.) under tubs, or similar *tight* receptacles or covers such as large pails, buckets, or boxes. The chemical is employed at the rate of 1 dram (about a teaspoonful) to each cubic foot of space; 2 drams, or a tablespoonful, will serve for ordinary small tubs. This method of treating the plant does not injure it, and if the tub or other cover fit tightly to the ground so as to retain the vapor of the disulphid, all of the plant-lice which are covered will be killed. This method has been used successfully in moderately large fields, but the grower must be careful to watch the vines for the first appearance of the insects and treat promptly the hills that require fumigation, removing and destroying plants that are badly affected to prevent the spreading of the infestation to others.

Caution.—In the use of carbon disulphid as a fumigant for the melon aphis or other plant-lice the usual precautions should be observed not to expose the carbon disulphid vapor to fire, as it is inflammable and explosive if mixed with air in certain proportions. *The operators must not smoke during this process.* As the gas is heavier than air there is no danger, if ordinary care be observed, that the vapor will be inhaled by human beings.

CULTURAL METHODS.

Cultural methods give considerable promise in control. Clean gardening or farming with fall plowing should always be practiced, as this forms a most valuable measure of prevention of injury by this and other insects that are almost always present in the same fields. As soon as the crop is off, the remnants should be gathered and burned. All weeds in the vicinity should be kept down throughout the year, including late fall and early spring, since, as has been shown, the common weeds of the field and garden are available as food plants and serve as the hibernating quarters of the melon aphis, which feeds more or less throughout the warmer periods of winter. On weeds the insects can be found feeding, in a climate like that of the District of Columbia, until January, even after heavy frosts or snow, and again in March.

When cucumber or other plants become badly infested it is an impossibility to secure a crop of fruit. In such a case about the only measure that can be profitably undertaken is simply to dig out and bury the plants with the plant-lice on them as they are noticed when the hills are turned over for cultivation. In small gardens

[1] See also Farmers' Bulletin 799, "Carbon Disulphid as an Insecticide," which may be obtained free on application to the Division of Publications, United States Department of Agriculture.

single plants may be pulled and covered over with a spadeful o earth to prevent spread of the infestation. This method is ver generally practiced for the melon aphis as well as for many othe truck-crop pests. Where the vines can be burned promptly this i still more valuable, as it insures the death of other insects, such a squash bugs, which are likely to be present at the same time.

FIG. 8.—Traction sprayer for use on cucumber and other truck crops.

CONCLUSIONS.

(1) Examine the melon or cucumber field in several places, fro time to time, in order that the melon aphis may not cause seriou damage before detection.

(2) When the aphis is found, *do not wait* to find out whether it i going to increase, but *begin spraying at once.*

(3) Be sure to use the correct formula, and apply it properly an thoroughly, making frequent inspections to ascertain that the unde sides of the leaves are well covered.

(4) Use plenty of spray-mixture—200 gallons to the acre, if neces sary—and apply at high pressure, say about 150 pounds, if possibl

If the work is undertaken in time, and directions are carefull followed, there should be no difficulty in protecting a field of cucum bers or melons against the ravages of the melon aphis and obtainin a good yield.

○

HOW TO REDUCE WEEVIL WASTE IN SOUTHERN CORN

C. H. KYLE
Assistant Physiologist, Office of Corn Investigations

FARMERS' BULLETIN 915
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. February, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

IN WEEVIL-INFESTED REGIONS ears with poor shuck coverings are damaged before the corn can be stored.

To store corn with short, loose shucks results in greatly increased loss.

Shucks that extend beyond the tips of the ears and close tightly about the silks are weevil proof both in the field and in storage.

Feed or sell the unprotected ears as rapidly as possible.

Store the weevil-proof ears in their shucks.

Select the best ears, in the field if possible, for next year's seed. Be sure that these ears have long, tight shucks, so that your next crop will have better shuck protection.

If necessary to store corn that does not have good shuck protection, the damage will be reduced if the corn is shucked, shelled cleaned, and put in bags of close-woven cloth.

A slatted crib lined with galvanized-wire netting having ¼-inch meshes is ideal for the storage of the bags of grain, because it gives good ventilation and excludes rats and mice.

HOW TO REDUCE WEEVIL WASTE IN SOUTHERN CORN.

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CORN GROWING IN THE SOUTH.

THE SOUTH is wonderfully adapted for corn growing, and the production of this valuable food crop is increasing rapidly. A serious obstacle to the increase of profitable corn production in many sections is the prevalence of insects which have made it impracticable to hold the crop until it can be most profitably used.

It is the custom in Southern States to store the corn crop in its shucks, because it is more or less vaguely known that some of the ears are protected by their shucks. It is also well known that many of the ears with a poor shuck covering become infested, and often badly damaged, both in the field and in storage. Yet the storing of these infested ears along with the shuck-protected ears is still the usual practice.[1]

Just now, when it is essential that all possible waste be prevented and that food production be increased as much as possible, it is fortunate that a method can be announced which can be immediately used to effect a great reduction in insect damage.

POOR SHUCK PROTECTION RESULTS IN SERIOUS DAMAGE.

It has been found that, in weevil-infested sections, the ears with tips protruding from the shucks or with loose, open shucks usually become infested and often seriously damaged before they can be safely stored and that many of them after several months in storage are worthless (fig. 1).

GOOD SHUCK COVERINGS MAKE EARS WEEVIL PROOF.

Experiments have shown that shuck coverings extending well beyond the tips of the ears and closing tightly about the silks, if not opened by other means, will resist weevils successfully, both in field and in storage (fig. 2). When the weevils have been confined with shuck-protected ears and have had no other source of food, they have

[1] The Bureau of Entomology has long recognized the value of a long, tight husk as a protection against weevils, and the growing of such corn has been practiced by some southern farmers with satisfying results.

not been able to cut through to the grain and have starved as a result. The average results with 14 representative southern varieties show about 40 per cent of the ears to be weevil proof in this way.

EARWORM DAMAGE REDUCED BY GOOD SHUCK COVERING.

Investigations indicate that the earworm is the greatest handicap to shuck protection against weevils. Under ordinary planting conditions [1] it has been found that fully half of the weevil-proof shuck coverings are opened by worms, and through the holes thus made weevils often reach the grain. However, it was found also that weevil-proof shucks through which worms had cut holes afford much

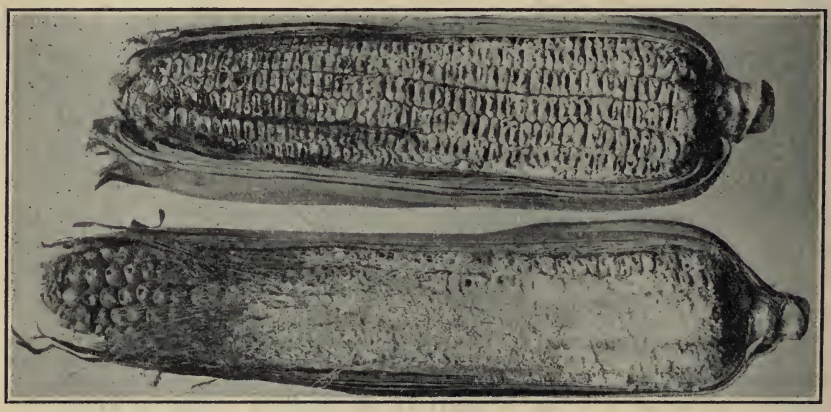

FIG. 1.—Ears of corn with poor shuck protection after 10 months in field and storage where weevils were very abundant. Avoid this loss by selling or feeding corn with short husks.

better protection against weevils than those but poorly inclosing the ears.

Earworms usually enter the shuck covering through the silk channels, feeding on the silks as they go, and the holes through the shucks are made when the worms are leaving. It has been found that when there is a long shuck extension, the worms frequently cut from the silk channels before reaching the ear, and the longer the extension the more frequently this happens. In this way shuck extension prevents worms from directly damaging the grain and from opening the way for weevils and mold.

THE CORN BREEDER'S OPPORTUNITY.

Here is a rare opportunity for the corn breeder. Not only should he strive to produce a variety in which all of the ears will be clothed with shucks that extend tightly beyond the tips of the ears, but the shuck extension should be several inches long (fig. 3).

[1] Small areas of corn caused to mature out of season invite concentrated attacks by the earworms. For this reason corn produced by exceptionally early maturing varieties or from exceptionally late plantings of common varieties may have practically all of the shuck coverings cut by worms.

A PRACTICAL SYSTEM OF MANAGEMENT.

It is evident from the results obtained that so far as weevil damage is concerned the advantage or disadvantage of storing corn in the shucks is determined by the kind of shuck covering on the ears stored. In all varieties that are exposed in the field there are more or fewer ears with poor shuck coverings that have become infested with weevils. To store such ears in their shucks after the grain has become infested is to make conditions most favorable for the insects. To shuck such ears in the field is to leave a part of the insects behind, but as the ears will still contain adults, larvæ, and eggs, destruction will continue, and they will remain a source from which uninfested but exposed corn may become infested. On the other hand, there are more or fewer ears in varieties native to weevil-infested sections which, because of their effective shuck covering, do not become infested with weevils. To store such ears in their unopened shucks is to afford them continued protection. To shuck such ears is to expose them to the attacks of insects, including the Angoumois grain moth, unless they are protected by other means. The average farmer does not use other effective means of protection because they involve additional cost, and, in the case of fumigation with carbon disulphid, extra fire risk. Even in the case of those storing their corn in unusually tight bins and fumigating with large quantities of carbon disulphid two or three times a year, the insect damage usually continues, though at a slower rate than otherwise would be the case.

FIG. 2.—Ears of corn with good shuck protection after 10 months in field and storage where weevils were very abundant. Keep this kind of corn for storage. Select the best ears with long tight husks for next year's seed.

Shuck protection involves no additional cost and no extra fire risk and is effective to the extent of its development. Therefore, to

minimize the loss due to insects the following general plan is recommended to the average corn grower in weevil-infested sections: *Grow the best shuck-protected corn; store the weevil-proof ears in their shucks; and shell and clean and feed or sell the unprotected ears as early as possible.*

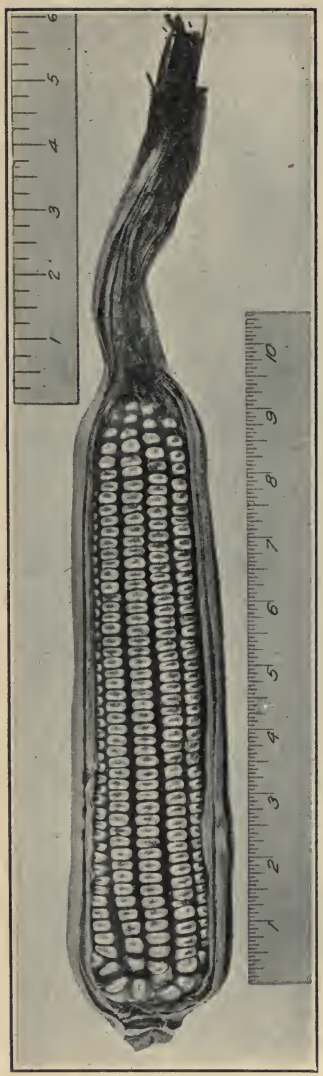

FIG. 3.—The breeder's ideal ear of corn. Shuck protection like this will reduce insect damage in the field and in storage to a negligible quantity.

HARVESTING, SORTING, CLEANING, AND STORING.

The harvesting should be done as soon as the corn is sufficiently dry. After harvesting, the ears should be sorted into two classes. This can be done rapidly with ordinary farm labor at a time when it is too wet or stormy for field work.

The first class should include all of the ears that apparently have weevil-proof shucks. These ears should be stored in their shucks until such time as they are needed.

The second class should include all ears with tips protruding beyond the shucks, with loose or open shucks, and any others that are probably infested with weevils. These ears require immediate attention to minimize the loss, as the weevils in them will continue to multiply except during the coldest part of the winter season. As the shucks of poorly covered ears are no protection, they should be removed. Already some of the ears may be partially consumed and contain adult insects, larvæ, and eggs. These should be kept separate and are best suited for poultry feed. All the ears showing slight infestation should be shelled and the grain cleaned to remove the live weevils. If the sheller has fans and riddles it may not be necessary to run the corn through a separate cleaner. If the sheller has no cleaning devices, a fanning mill will serve the purpose.

The shucking, shelling, and cleaning will dislodge many of the insects, and so far as possible these should be collected and burned.

In many cases, to prevent further loss before the corn can be used or sold, it will only be necessary to put it in bags woven sufficiently close to prevent the weevils from pushing through from the outside. They will seldom cut through even the thinnest cotton bagging. It should be remembered, however, that though the bags prevent weevils from entering, they do not prevent the weevils already in the corn at the time of sacking from continuing to breed and damage the grain.

If it is necessary to keep this infested bagged corn for a considerable length of time, the multiplication of weevils within the sacks can be minimized by fumigation or by running the grain through a fanning mill occasionally. The warmer the weather the oftener this is advisable.

The shelled corn must not be stored in large masses or it may heat during periods of high temperature. A slatted crib lined with galvanized-wire netting having ¼-inch meshes is ideal for the storage of the bags of grain, because it not only gives abundant ventilation but excludes rats and mice.

With gas-tight storage bins the weevils in infested corn may be effectively destroyed with carbon disulphid. Farmers' Bulletin 799, entitled "Carbon Disulphid as an Insecticide," which discusses this subject fully, may be obtained without charge from the Division of Publications, United States Department of Agriculture.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE OF INTEREST IN CONNECTION WITH THIS BULLETIN.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Corn Cultivation. (Farmers' Bulletin 414.)
Seed Corn. (Farmers' Bulletin 415.)
A Corn-Belt Farming System Which Saves Harvest Labor by Hogging Down Crops. (Farmers' Bulletin 614.)
Grain Farming in the Corn Belt with Live Stock as a Side Line. (Farmers' Bulletin 704.)
Corn Culture in the Southeastern States. (Farmers' Bulletin 729.)
The True Army Worm and Its Control. (Farmers' Bulletin 731.)
Cutworms and Their Control in Corn and Other Cereal Crops. (Farmers' Bulletin 739.)
The Fall Army Worm, or "Grass Worm," and Its Control. (Farmers' Bulletin 752.)
Corn Growing under Droughty Conditions. (Farmers' Bulletin 773.)
How to Detect Outbreaks of Insects and Save the Grain Crops. (Farmers' Bulletin 835.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

The Cotton Bollworm: A Summary of Its Life History and Habits, with Some Results of Investigations in 1905 and 1906. (Farmers' Bulletin 290.) Price, 5 cents.
Harvesting and Storing Corn. (Farmers' Bulletin 313.) Price, 5 cents.
The Larger Corn Stalk-Borer. (Farmers' Bulletin 634.) Price, 5 cents.
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The So-Called Tobacco Wireworm in Virginia. (Department Bulletin 78.) Price, 5 cents.
Wireworms Attacking Cereal and Forage Crops. (Department Bulletin 156.) Price, 5 cents.
The Southern Corn Leaf-Beetle. (Department Bulletin 221.) Price, 5 cents.
Termites, or "White Ants," in the United States, Their Damage, and Methods of Prevention. (Department Bulletin 333.) Price, 15 cents.
The Pink Corn-Worm: An Insect Destructive to Corn in the Crib. (Department Bulletin 363.) Price, 10 cents.
The Spike-Horned Leaf-Miner, an Enemy of Grains and Grasses. (Department Bulletin 432.) Price, 5 cents.
The Desert Corn Flea-Beetle. (Department Bulletin 436.) Price, 5 cents.
Relation Between Rotation Systems and Insect Injury in the South. (Separate 561, Yearbook 1911.) Price, 5 cents.
The Slender Seed-Corn Ground-Beetle. (Bureau of Entomology Bulletin 85, Part II.) Price, 5 cents.
The Broad-Nosed Grain Weevil; The Long-Headed Flour Beetle. (Bureau of Entomology Bulletin 96, Part II.) Price, 5 cents.
The Lesser Grain-Borer; The Larger Grain Borer. (Bureau of Entomology Bulletin 96, Part III.) Price, 5 cents.
A Little-Known Cutworm. (Bureau of Entomology Bulletin 109, Part IV.) Price, 5 cents.
The Larger Corn Stalk-Borer. (Bureau of Entomology Circular 116.) Price, 5 cents.

A SUCCESSFUL COMMUNITY DRYING PLANT

C. W. PUGSLEY
Director of Agricultural Extension, University of Nebraska

FARMERS' BULLETIN 916
UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D. C. December, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

A SUCCESSFUL COMMUNITY DRYING PLANT located at Lincoln, Nebr., is described in this bulletin. Practically the same plan was followed in eleven other communities—nine of them in Nebraska—during the summer and fall of 1917, and the experience is related at this time in answer to a demand for information of this character for consideration at farmers' meetings during the winter.

The plan proved successful under conditions found in the locality of Lincoln. Much is yet to be learned concerning home, community, and commercial drying, and next season may add materially to the present rather meager but useful information.

Any person interested in the subject of community drying of fruits and vegetables will find valuable suggestions in Farmers' Bulletins 841 and 903, as well as in this publication. They may be obtained free upon application to the Division of Publications, United States Department of Agriculture.

A SUCCESSFUL COMMUNITY DRYING PLANT.

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PRINCIPLE USED IN DRYING.

THE DRYING PLANT described in this bulletin follows closely the specifications of a community plant at Lincoln, Nebr., and 11 others in that general section, all of which were operated successfully during the summer and fall of 1917. It is an adaptation of the electric-fan process of drying. A stream of dry air is caused to flow continuously over the products being dried. The humidity of the air, the method of preparation of the vegetables, and the velocity of the air current have much to do with the rapidity of drying. It is easy to understand how this process operates, when we consider how rapidly wind

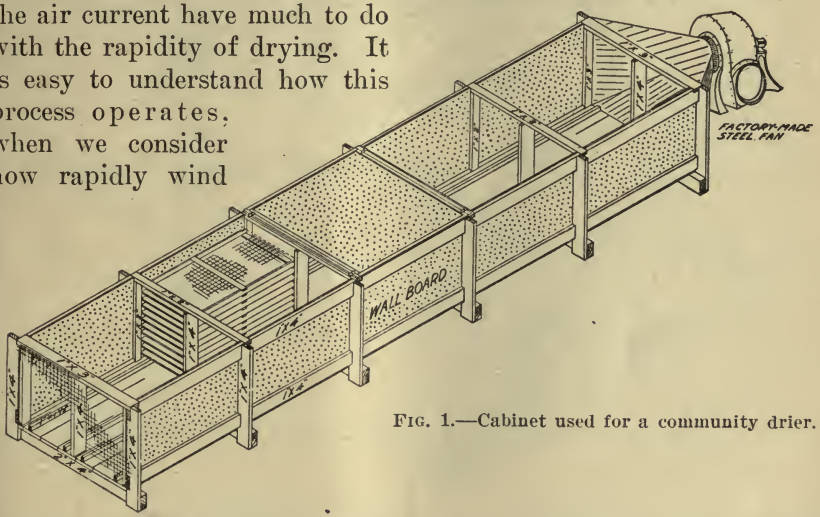


FIG. 1.—Cabinet used for a community drier.

will dry roads after a rain, or how much more rapidly clothes dry in a breeze than when the air is quiet.

Instead of the air being forced across the vegetables, as is done in some methods, the air is drawn across them. Laboratory tests indi-

cate that drying is considerably accelerated when the suction method is used, although the force method will dry satisfactorily and is used in at least one Nebraska plant.

A simple community drying plant to be of most value should be easily constructed from material ordinarily found in the community. It should be possible to operate such a plant without expert help and by power easily available. The drying plant here described can be built complete for $250 or less. The cost usually can be reduced greatly by using material already on hand. At the time of the writing of this bulletin 12 of these plants were in successful operation.

A long cabinet is constructed as shown in figure 1. Ordinary flooring may be used to construct the bottom, and either flooring or wall board for the sides and top. For convenience the openings are placed at the top of the cabinet. The suction holds the lids firmly in place. In practice it has been found unnecessary to use lid fasteners.

The trays are stacked inside the cabinet as shown in the cut. The drier here illustrated is designed for 100 trays, there being five compartments, each containing 20 trays arranged in tiers of 10. Details for the construction of the cabinet are shown in a closer view of the intake end in figure 2, cross section in figure 3, and side elevation in figure 4.

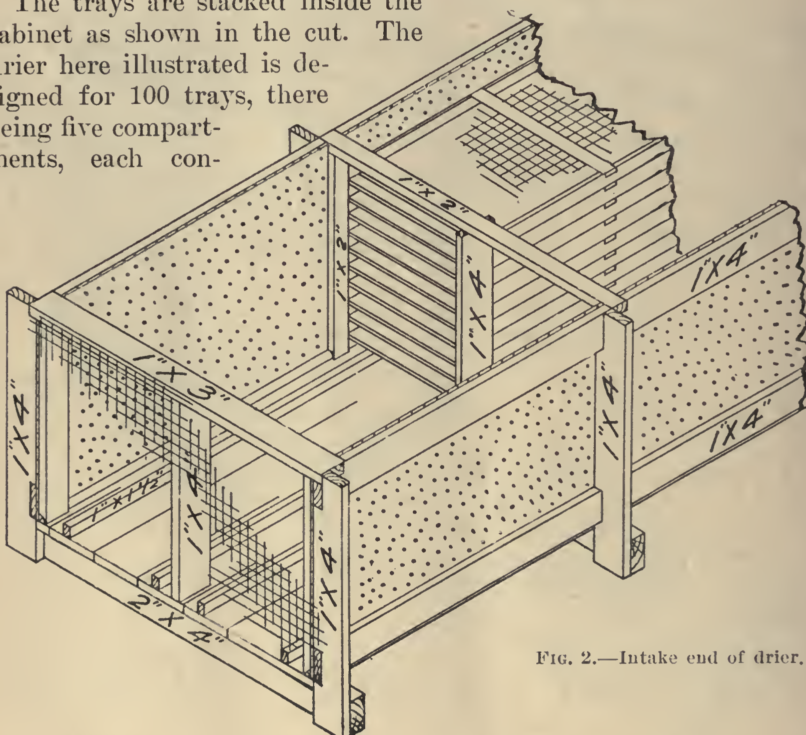


FIG. 2.—Intake end of drier.

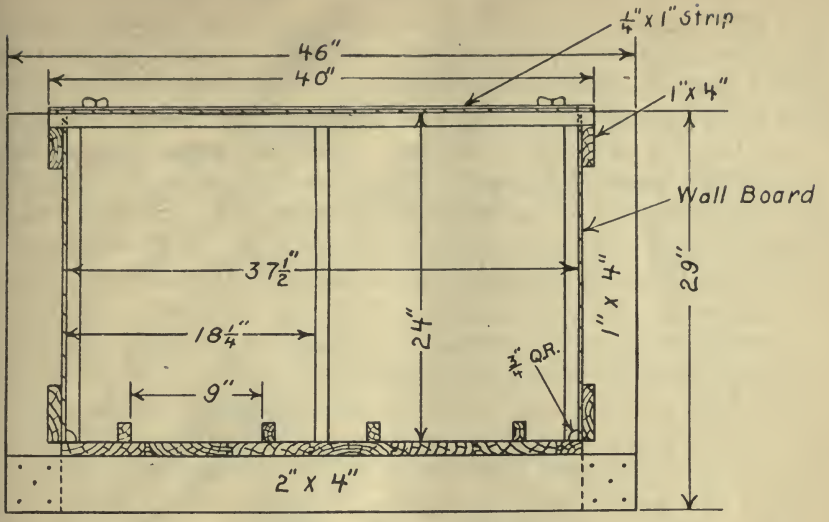


FIG. 3.—Cross section of drier.

A bill of materials for the construction of the cabinet follows:

2 pieces--2" by 4" -------12' long.
7 pieces--1" by 6" M. F--18' long.
2 pieces--1" by 4" -------16' long.
4 pieces--1" by 4" -------18' long.
1 piece --1" by 4" -------12' long.
1 piece --1" by 3" -------16' long.
1 piece --1" by 2" -------16' long.
1 piece --1" by 2" -------14' long.
4 pieces--1" by 1½" ------18' long.
2 pieces--½" by 1" -------10' long.
2 pieces--½" by 1" -------14' long.
2 pieces--¼" by 1" -------18' long.
1 piece --¾" by Q. R------18' long.
1 piece --Wall board 48" by 49'.
Wire screen, 24" by 40", for intake end.
This bill for cabinet, without fan.

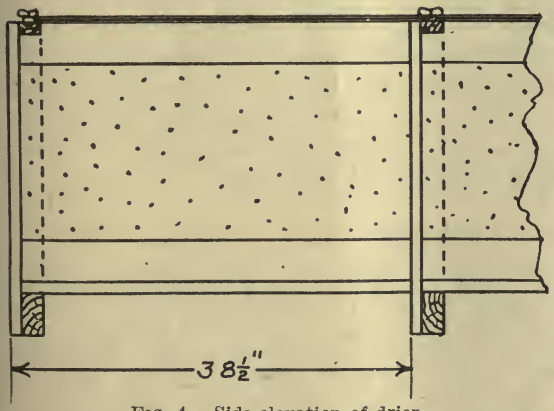


FIG. 4.—Side elevation of drier.

TRAYS FOR DRYING.

The tray 18 inches by 36 inches, shown in figure 5, has been found to be admirably adapted to community work. It holds about the quantity of material of one kind ordinarily brought by the family for drying. It is light and easily handled, the support across the top serving as a convenient means of lifting. These trays should be made of very light material, with

wire-screen bottoms and wire screen at one end, the other end being left open. The screened end prevents light material from being drawn through, while the open end permits free access of air and ease in emptying the trays. The screened end should always be turned toward the fan when suction is used. This same type of tray is admirably adapted to the electric-fan method of home drying by stacking these trays one on the other and placing the fan at the open end of the trays.

Following is a bill of material for making 100 trays:

50 pieces—½" by 2"—12' long.
38 pieces—½" by 1½"—12' long.
50 yards wire screen, 26 inches wide.

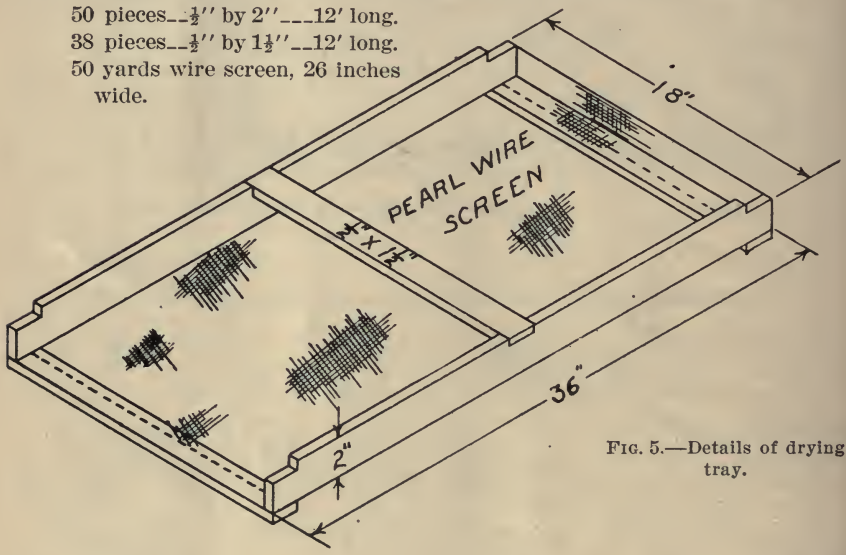


FIG. 5.—Details of drying tray.

The wire-screen trays should be paraffined to prevent the sliced fruits and vegetables from sticking. This can be done easily by warming the wire and applying melted paraffin with a brush. If any of the paraffin fills the meshes they can be opened by holding over a stove until the paraffin melts and distributes itself over the wire. The paraffin prevents all possibility of discoloration of fruits and vegetables by coming in contact with the wires.

THE FAN.

Any type of fan which moves a sufficient quantity of air can be used. Usually an old ensilage cutter blower fan or a separator fan used on a blower thrashing machine can be found in the community and adapted to the exhaust end of the cabinet. One of the Nebraska plants has been fitted with a fan which had been discarded at a planing mill, having been used there for drawing sawdust and

shavings from the planing machines. Another plant was fitted with an exhaust fan which had been used in a foundry for the removal of gases at the forges. Other plants are fitted with fans costing from $25 to $50. Suitable fans can be purchased from any of the fan manufacturing companies.

The main point to keep in mind in the selection of a fan is to get one that will move a sufficient quantity of air. The figures given are for a drier the size here described and give the rate of air movement when the cabinet contains no trays. Air should enter the cabinet at a rate of not less than 1,000 feet per minute, and better results will be secured if the speed is 1,250 feet per minute. This means that the fan should move air at the rate of 7,500 cubic feet per minute, which will change the air in the cabinet approximately 75 times per minute. If the fan will move air fast enough for the suction to hold a piece of cardboard or other material 1 foot square and weighing 8 ounces against the wire screen at the intake end, the drying will proceed satisfactorily.

The most important feature to watch in the construction of a drying plant of this type is the fan. It should be simple in construction, easy of operation, and, above all things, large enough to move great quantities of air. When the 100 trays are filled with fruits and vegetables it is necessary to move the air rapidly to prevent souring and molding.

THE MOTOR.

The fan may be operated by an electric motor of from 2 to 5 horsepower or by a gasoline engine of similar power. With an electric motor the only attention needed in operating is oiling the fan and occasionally the motor. A gasoline motor will require more attention in the way of oil and fuel supply, but even this is simple to operate and understood in every community.

THE USE OF HEAT IN DRYING.

Nebraska's experience with community drying indicates that ordinarily a better-colored and better-flavored product is obtained if no artificial heat is applied. Even in arid countries, however, and always in humid countries, it is best to have equipment for heating. This will be needed when the air contains much moisture, as during rainy spells. Heating the air in the room in which the drying is done will lower its humidity and facilitate the drying. If the temperature of the air is raised above 120° Fahrenheit, however, some of the dried products may be discolored or the natural flavors may

be changed. Therefore a heating device should be such that the temperature of the air will not be raised greatly. It should also be one which can be easily constructed from material found in the community.

A very effective method of heating the air is by the use of a hot-water radiator placed at the intake end of the drier, as shown in figure 6. The water in this radiator can be easily heated by means of a small hot-water heater connected as shown in figure 7.

The air is drawn through the hot-water radiator and in passing through becomes sufficiently heated to raise its temperature considerably, thus lowering the percentage of humidity.

The simplest method of raising the temperature of the air is by having the intake end of the drier in a room in which there is a stove. If this is not convenient a small room or compartment of sufficient size to contain a stove can be constructed of cheap material, such as wall board. The stove should be within a few feet of the

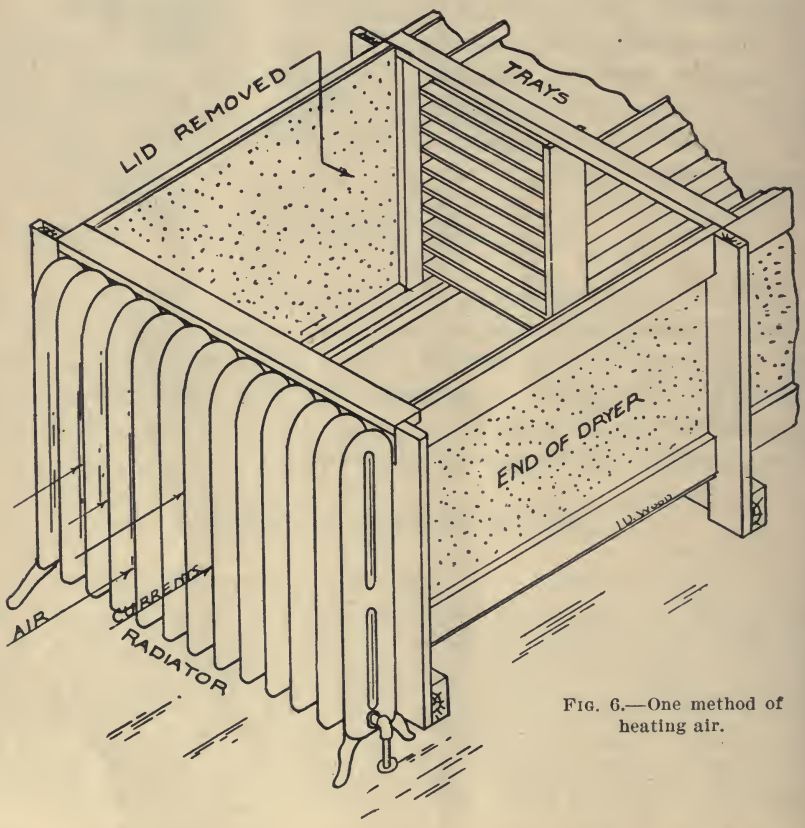


FIG. 6.—One method of heating air.

intake end. A good hot fire in the stove will do wonders in accelerating the drying on humid days. Caution should be observed to avoid fire in view of the strong draft flowing from the hot stove to the inflammable dryer.

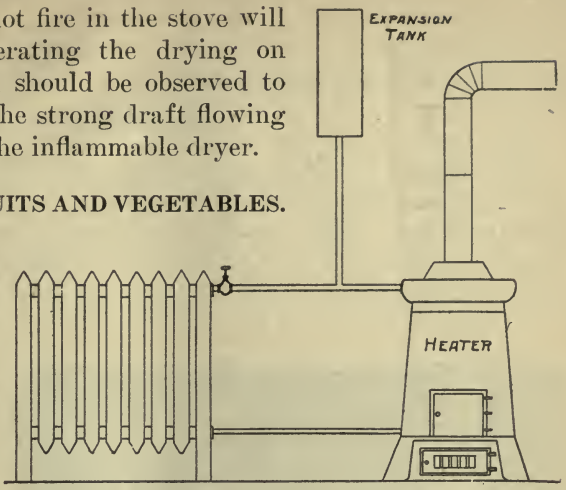


FIG. 7.—One method of heating water.

PREPARATION OF FRUITS AND VEGETABLES.

The fruit or vegetables should be cleaned as for table use. After cleaning they should be sliced thin. The slicing process may be hastened by the use of some slicing device, such as a rotary slicer, two types being shown in figure 8. The one in the foreground is listed at $2 and the larger one at $10. These slicers are similar to the bread slicers or dried-beef slicers ordinarily used.

For the satisfactory use of this method of drying it is essential to slice all material thin, so that as many of the inner cells as possible will be exposed to the action of the air current. The sliced fruits or vegetables are spread over the wire-screen trays and the trays placed in the cabinet. Figure 9 shows equal quantities of rhubarb before and after drying and indicates the method of placing on the trays.

Certain vegetables or fruits will discolor unless specially treated. Apples usually turn dark when dried. This can be prevented by dipping the sliced apples in a solution of ordinary table salt and then placing immediately on the trays for drying. This solution can be made by using 2½ level teaspoonfuls of salt to a quart of water. Irish potatoes will discolor somewhat and can not be satisfactorily dried by this method unless they are first cooked. They can be boiled until soft, then passed through a ricer, or they can be sliced and then steamed thoroughly before placing on the trays.

In drying corn it is well to set the milk by cooking in boiling water for about 5 minutes or by cutting the corn from the cob in the raw condition and placing the corn in a slow oven and heating until the milk is set. The latter method seems to give the best-flavored and best-colored corn, but great care must be exercised not to use too much heat. Some vegetables, such as string or snap beans and shelled peas, may be blanched in live steam or boiling water for 5

to 15 minutes, but this is not essential. Practically all fruits and vegetables, with the exceptions noted above, can be prepared in their raw state and dried satisfactorily.

STORING.

The enemies of dried fruits and vegetables are moisture, insects, and rodents, and successful storing will depend on protection against these enemies. After a sufficient amount of moisture has apparently been removed, it is well to keep the product for several days in a large container which can be protected by either a cloth cover or a wire screen. If after a few days there is any indication of moisture collecting on this dried product, it should be dried in pans in the oven or exposed to the sun or air current for a few hours and then packed in the permanent containers. Any sort of container which will prevent the product from absorbing moisture and protect it from insects and rodents will answer the purpose. Tin cans, glass jars, and, for some products, paraffin containers, pasteboard boxes, and paper sacks make good receptacles. Tin cans or glass jars can be stored with safety anywhere. If packed in paraffined containers, paper bags, or pasteboard boxes, the products should be stored in a very dry place and where rodents can not get at them.

FIG. 8.—Types of rotary slicers.

Special precaution should be taken against the possibility of moths laying eggs on the dried products during the process of drying or before packing in the permanent containers. If these eggs are on the fruits or vegetables, they will hatch if conditions are favorable, and resulting caterpillars will render the product useless.

It is best to pack the fruit or vegetables in small containers of about the size to supply a sufficient amount for use at one or two meals. This will lessen the chance of large quantities being spoiled.

COOKING DRIED FRUITS AND VEGETABLES.

In cooking evaporated fruits or vegetables it is essential to remember that they must be soaked in cold or tepid water before they are cooked. The length of time will depend on the product. With most products, soaking overnight does no harm. If soaked overnight, they should be left in a cool place to avoid souring. The object is to get back into the cells the water which was taken out by the process of evaporation. In soaking it is well to use a sufficient amount of water to soak properly and still leave enough for cooking. Ordinarily the product should be cooked in the same water in which it is soaked, for the water will contain some of the pleasing flavors and valuable nutrients. In the case of vegetables or fruits which have a strong or bitter taste, such as turnips, a more pleasing flavor may be obtained by changing the water while cooking or soaking.

IMPORTANCE OF COMMUNITY DRIERS.

Municipal or Government-owned drying plants have been in successful operation in European countries for years. Such plants provide village communities with a convenient and simple method of drying all sorts of produce of the home garden and orchard, as well as the vegetables and fruits shipped to the community, which might be allowed to go to waste at the stores and market places. The advantage to the busy farmer's wife in the country community can not be overestimated. Her work is heaviest in the summer when vegetables and fruits must be saved for winter use. The establishment of a community drying plant at a consolidated school, country church, or centrally located farm home would offer a great relief

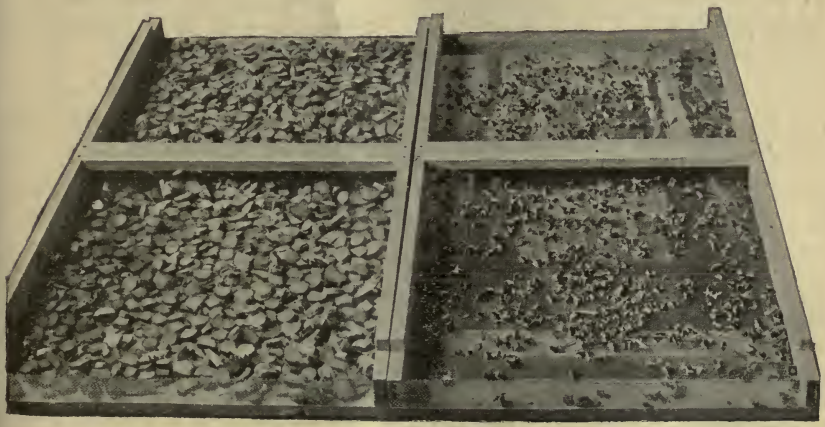


FIG. 9.—Trays of fresh and dried rhubarb.

from her heavy kitchen duties. The housewife could clean and slice at least a portion of the fruits and vegetables she desires to conserve, and either take these or have one of the children take them to the community drying plant, where they could be left until it was convenient to call for the dried product.

OPERATION OF COMMUNITY DRIERS.

Municipalities might well establish plants from municipal funds, the work being supervised by the city council or other town authorities. If the plant is not a municipal plant it is best to place it under the guidance of some association already in existence, such as a civic improvement club, commercial club, or home-school garden club, or by a special community club organized for the purpose.

In one community where a drying plant is established, a special community club of approximately 60 families has been organized, primarily to look after the operation of the drying plant. The officers, consisting of president, vice president, secretary, and treasurer, constitute the executive committee, and are entrusted with power to act. A simple form of constitution and by-laws was adopted, and meetings of the club are held monthly or oftener, usually at the drying plant, which in this community is in a room of a church building.

Whether the plant is operated by a municipality or by a community club, it is necessary to have a caretaker who will be at the plant during certain hours of the day to receive and deliver fruit and vegetables, to keep the plant in proper condition, and to keep the fan and motor running. Usually it is best to have the plant open to the public from two to four hours a day, say, from 10 to 12 oclock in the mornings and from 4 to 6 o'clock in the afternoons. The caretaker should live near the plant. In case a community plant is established in a country district it would be well to have the plant located at the home of the caretaker.

The caretakers may be paid by the hour for their services, and the money may be obtained by making a charge of from two to five cents a tray for the privilege of drying. Unless the motor power is supplied by the municipality, club, or some public-spirited individual, it is necessary to make this charge sufficiently large to cover the cost of operating the motor.[1]

[1] The following bulletins will be sent free on application to the Division of Publications, United States Department of Agriculture, Washington, D. C.:

Home Canning by the One-Period Cold-Pack Method. Farmers' Bulletin 839.

Drying Fruits and Vegetables in the Home. Farmers' Bulletin 841.

Home Canning of Fruits and Vegetables. Farmers' Bulletin 853.

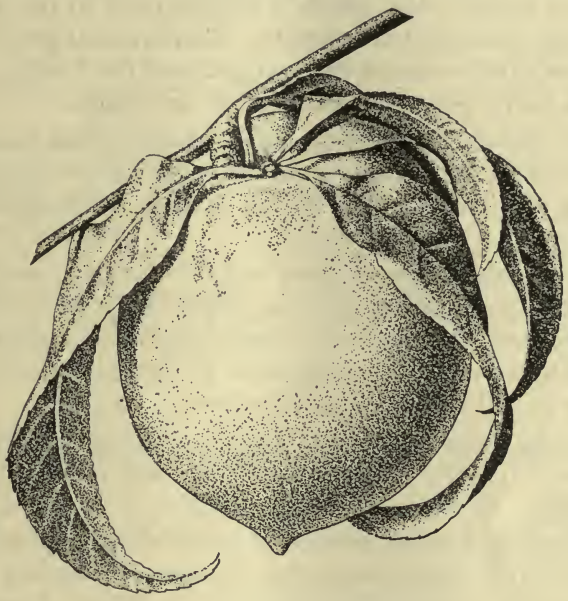
Other bulletins on canning and drying can be obtained by writing to the State Agricultural Colleges.

GROWING PEACHES

SITES AND CULTURAL METHODS

H. P. GOULD

Pomologist, Office of Horticultural and Pomological Investigations



FARMERS' BULLETIN 917

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C. March, 1918. (Revision and combination of Nos. 631 and 632)

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

IN ITS commercial and economic importance in this country the peach is second only to the apple among deciduous-tree fruits. Commercial peach interests exist in about three-fourths of the States, with some home plantings in most of the others.

The peach grower who has had only limited experience will find in this bulletin information concerning some vital factors which largely determine the success of a peach orchard.

Emphasis is placed upon suitable location and site, because a faulty choice of either may be fatal to future financial success. Some mistakes in planning an orchard can be overcome as the orchard develops, but a poor location or site is beyond remedy.

The basic operations of planting, tillage, maintaining soil fertility, and pruning are discussed in this bulletin.

Spraying for the principal insects and diseases of the fruit is discussed in Farmers' Bulletin 440. Choice of varieties for planting in different regions is considered in Farmers' Bulletin 918. Both of these bulletins can be secured free of cost on request to the Department of Agriculture.

The present bulletin is a revision and combination of the two publications formerly issued as Farmers' Bulletins 631 and 632.

GROWING PEACHES: SITES AND CULTURAL METHODS.

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DISTRIBUTION AND STATISTICS OF PEACH GROWING.

ALTHOUGH census figures of 1910 are nearly obsolete, there is no better way of showing the trend of the peach industry during the past generation, so far as the distribution of orchards is concerned, and its present extent, than by means of these figures, which are shown in Table I. Perhaps there is no more interesting deduction to be made from the figures than the widespread cultivation of the peach. In at least 39 of the 48 States there are peach interests of commercial importance. The limiting factor in the States where few trees are grown is doubtless extremely low winter temperatures. Yet in the milder portions of even these States, especially in protected locations, the growing of peaches is not an impossibility. It is obvious, however, that where the limit of possibility is approached, the number of crop failures may be expected to be large in comparison with the number of good crops.

Wide differences appear in the number of bearing trees in certain States in the different 10-year periods, some of which indicate a very large increase, while others show a large decrease in the peach industry. In some of the important peach-producing States in 1910 there were also nearly as many trees—in several instances considerably more—*not* of bearing age than of bearing age.

TABLE I.—*Distribution of peach trees,[a] by States, as shown by census reports.*

States.	Number of trees of bearing age—			Trees not of bearing age, Thirteenth Census, 1910.
	Eleventh Census, 1890.	Twelfth Census, 1900.	Thirteenth Census, 1910.	
New England:				
Maine	1,607	9,592	5,102	3,320
New Hampshire	19,057	48,819	57,571	35,213
Vermont	1,966	4,993	5,492	2,187
Massachusetts	87,004	301,405	154,592	162,114
Rhode Island	11,816	48,063	39,342	30,795
Connecticut	88,655	522,726	461,711	338,608
Middle Atlantic:				
New York	1,014,110	2,522,729	2,457,187	2,216,907
New Jersey	4,413,568	2,746,607	1,216,476	1,363,632
Pennsylvania	1,146,342	3,521,930	2,383,027	2,179,386
East North Central:				
Ohio	1,882,191	6,363,127	3,133,368	2,092,300
Indiana	953,980	2,925,526	2,130,298	1,145,479
Illinois	783,910	2,448,013	2,860,120	739,358
Michigan	1,919,104	8,104,415	2,907,170	2,991,090
Wisconsin	387	6,967	4,163	4,148
West North Central:				
Minnesota	334	1,626	1,571	3,837
Iowa	82,238	516,145	1,090,749	283,308
Missouri	1,999,474	4,557,365	6,588,034	1,404,429
North Dakota	----------	2	90	604
South Dakota	78	1,080	1,815	5,259
Nebraska	144,701	1,055,959	1,188,373	263,882
Kansas	4,876,311	5,098,064	4,394,894	620,709
South Atlantic:				
Delaware	4,521,623	2,441,650	1,177,402	212,117
Maryland	6,113,287	4,017,854	1,497,724	805,063
District of Columbia	1,521	149	330	1
Virginia	1,218,219	1,939,113	1,585,505	780,551
West Virginia	450,440	1,695,642	1,424,582	1,441,188
North Carolina	2,133,004	2,773,788	2,661,791	861,042
South Carolina	711,138	1,136,790	1,336,142	349,790
Georgia	2,787,546	7,668,639	10,609,119	1,531,367
Florida	235,936	354,208	290,850	156,782
East South Central:				
Kentucky	1,205,866	2,884,193	2,245,402	1,110,744
Tennessee	2,347,699	2,749,203	3,163,737	1,190,727
Alabama	1,280,842	2,690,151	3,177,331	838,866
Mississippi	878,569	1,856,748	1,726,298	724,895
West South Central:				
Arkansas	2,769,052	4,062,218	6,859,962	2,884,927
Louisiana	317,132	758,877	903,352	316,132
Oklahoma	206	[b] 5,848,808	4,783,825	2,574,680
Texas	4,486,901	7,248,358	9,737,827	2,958,813
Mountain:				
Montana	----------	1,670	538	3,386
Idaho	13,639	79,757	73,080	212,995
Wyoming	----------	9	46	419
Colorado	8,204	319,998	793,372	606,001
New Mexico	23,081	117,003	136,191	184,466
Arizona	24,954	67,073	51,415	32,562
Utah	68,121	409,665	544,314	651,233
Nevada	3,996	9,136	6,329	5,049
Pacific:				
Washington	72,701	226,636	536,875	1,028,141
Oregon	115,244	281,716	273,162	508,179
California	2,669,843	7,472,393	7,829,011	4,409,562
Total	53,885,597	99,916,598	94,506,657	42,266,243

[a] Includes also nectarines, but the number of nectarine trees is so small as to be practically negligible.
[b] Includes Indian Territory.

LOCATION AND SITE.

The location of an orchard has to do with its general surroundings. It may relate to transportation facilities, markets, climatic conditions, and the geographical position of the district or region in which an orchard is placed, or, in other words, its local geography. The

site has to do with the particular piece of land occupied by the trees. It relates to the soil, slope, atmospheric drainage, and other natural factors which affect the suitability of a given area of land for peach growing.

A location may have every natural advantage as to climate, soil, and other local conditions for the successful growing of peaches and yet, because of its remoteness from a shipping station, distance from suitable markets, or even the impracticability of supplying ice for refrigerator cars, it may be impossible to market them profitably. Moreover, a location may have all these advantages to a satisfactory degree and yet not be desirable for commercial peach growing because the markets within its logical radius for distribution are already abundantly supplied with peaches from districts which in some important respects are more advantageously placed.

FIG. 1.—A fairly typical peach-orchard site in the Allegheny Mountain district of West Virginia, this being in Morgan County. In many instances the soil and other conditions in the valleys between the ridges are not well suited for peaches, even though the ridges may be admirably adapted to them.

It is likewise true that within a district which as a whole is well located for commercial peach growing there may be and usually are sites which are not adapted to this purpose, for reasons that are entirely local. This is especially apt to be the case in mountainous districts or wherever the topography is much broken and soil conditions are very variable. Especially careful discrimination in the selection of sites for orchards is essential in such districts. Figures 1 and 2 show typical orchard sites in important peach-growing districts in mountainous sections in widely separated parts of the country.

SITES WITH REFERENCE TO SOIL.

It is the current opinion that the peach should be planted on sandy or some of the lighter types of soil. Excellent results may follow the planting of orchards on such soils, but peaches do well also

on a wide range of soil types, including even some of the moderately heavy clay loams and clays. But whatever the type, a soil must be thoroughly well drained. Peaches will not succeed on poorly drained soils. The heavy clay types which are so hard and impervious that water does not percolate through them readily are to be avoided. Moreover, the soil should be moderately fertile. One very rich in nitrogen is not desirable as a general rule, since it may induce an excessive growth of foliage, but the impression that a poor, infertile soil is "good enough for peaches" is erroneous.

Where alkali soils occur, they should be avoided. While the peach tree can be grown where there is a limited amount of the alkali salts, they cause disaster if present in large quantities. It is safer, therefore, to avoid them as far as possible.

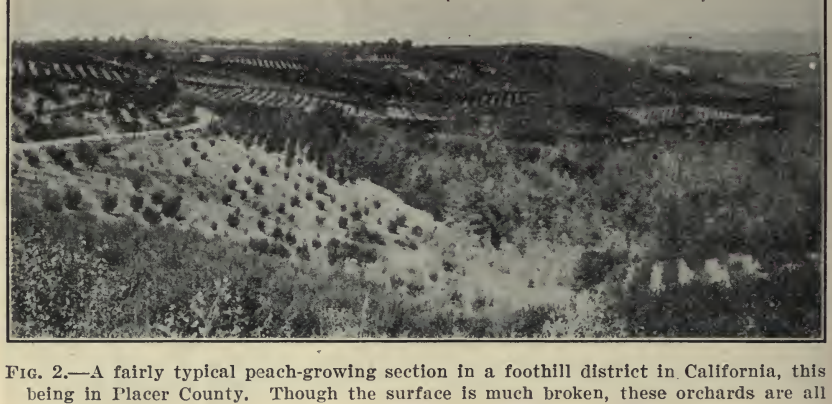

FIG. 2.—A fairly typical peach-growing section in a foothill district in California, this being in Placer County. Though the surface is much broken, these orchards are all irrigated.

SITES WITH REFERENCE TO ELEVATION.

Generally a site that is elevated considerably above the surrounding areas is to be preferred for a peach orchard. Cold air settles to the lower levels. For this reason it is often colder at the lower elevations than it is at higher points. This is what is meant by "atmospheric drainage." The occurrence of frost in low places when there is none on elevated areas is thus explained. For the same reason peach buds are often winterkilled or the blossoms are injured by frost in the spring in low places when near-by orchards on higher elevations are injured much less, or even escape entirely. During the past few years the importance of selecting relatively high sites for peach orchards in order to avoid the effects of unfavorable temperatures has been emphatically demonstrated in many different parts of the country. There are, however, certain general exceptions to the foregoing statement. Where an orchard that is well elevated above the surrounding country is exposed to low temperatures which are accompanied by severe winds, the fruit buds

are sometimes injured, when in the orchards at lower levels in the same locality, where there is protection from the wind, no injury occurs. However, injury under these conditions is rather rare in comparison with that which occurs in orchards that occupy relatively low sites.

SITES WITH REFERENCE TO BODIES OF WATER.

Where an orchard has a site adjacent to a body of water of sufficient size and depth to have an appreciable influence on the local climate, the importance of a relatively high elevation largely disappears. Because water warms up in the spring more slowly than the atmosphere, it acts in effect as a refrigerator, making the temperature in its immediate vicinity colder than at points somewhat distant from it. Vegetation within the zone of this influence advances more slowly in the spring than it does outside of that zone. The tendency is for the blossoming of peach trees within the zone to be delayed until after the season of spring frosts is past.

In the fall, frosts are delayed. The water, having absorbed much heat during the summer, cools off in the fall more slowly than the atmosphere and tends to keep the temperature within its zone of influence warmer than it would otherwise be.

For these reasons peaches are grown with marked success in the portions of New York and the Province of Ontario that border Lake Ontario; in Ohio along Lake Erie; in southwestern Michigan on Lake Michigan, and in some other districts adjacent to large bodies of water. The influence of such bodies of water usually does not extend back from the shore more than a few miles, though the slope of the land with relation to the water determines largely the extent of the area affected.

SITES WITH REFERENCE TO SLOPE.

The slope or exposure of a site has reference to the point of the compass toward which the land inclines. No one slope is preferable under all conditions and in all regions. A site having a moderate slope in some direction probably is to be preferred for orchard purposes to one that is level, as one with a slope will usually have better soil and atmospheric drainage than a level area; but one slope may be as good as another.

An orchard that occupies a site which slopes away from the prevailing wind may be afforded a certain amount of protection therefrom, and in some regions there are well-marked soil differences on the different slopes of the ridges. These differences may be such as to make one slope better adapted to peach growing than another.

The slope factor, however, is largely one of degree. Peach trees on a site having a very steep southern slope will usually blossom and

the fruit will ripen somewhat earlier than on a corresponding northern slope, but where the differences in slope are only moderate their relative influence on the time of blossoming and ripening is not very marked. Whether early or late blossoming is desirable is largely a local matter and depends primarily on the relative dates of blossoming and the usual occurrence of spring frosts in any locality or on any site.

TEMPERATURE A LIMITING FACTOR.

Aside from economic factors, temperature probably is the most decisive limiting factor in the distribution of commercial peach growing. Usually the fruit buds are the first to suffer injury. No absolute minimum temperature which the peach is able to withstand without injury can be given. The condition of the buds with regard to their strength, vitality, and perfect dormancy, the duration of the critical temperature, the climatic conditions following the cold period, perhaps the amount of moisture in the air during the period, and other factors all have an influence.

In many peach districts, however, the growers are always apprehensive of injury, even with buds in good condition and all other factors favorable, whenever the temperature reaches 10° to 20° F. below zero, though buds of many varieties often withstand temperatures considerably lower than this when all other conditions are favorable.

Where severe spring frosts occur from year to year during the blossoming period it is not practicable to produce peaches on a commercial basis. Similarly, regions in which protracted warm periods occur from time to time during the winter have usually proved to be uncertain for peaches. The trees become more or less active during the warm periods; the buds start enough to become tender and are injured later even by temperatures which may not be unseasonable for the latitude. For this reason winter and spring injury is sometimes experienced in middle and southern latitudes, when peaches in the northern districts escape.

Orchard heaters offer a measure of relief under some conditions in districts subject to unseasonable spring frosts, but such districts are, nevertheless, seriously handicapped in comparison with those where disastrous frosts rarely occur.

PROPAGATION OF PEACH TREES.

The average peach grower is not concerned directly with the propagation of trees. It is generally more advantageous for him to purchase them from one who makes the growing of trees his special business than to grow them himself. However, the general features of propagation should be understood by those engaged in peach growing. They are, therefore, briefly outlined in the present connection.

The site selected for a peach nursery should be one that is well drained and where the soil is preferably rather light, though not necessarily sandy. It is important also that the soil should be rather rich, in order to insure as far as possible a satisfactory growth of the trees.

The details of propagating the peach begin with the pits or seeds from which the stocks are grown and on which the different varieties are budded. The pits are obtained by nurserymen from many different sources. They are handled in different ways, depending quite largely upon climatic conditions, the extent of the business, and other factors.

In the middle latitudes, where probably the largest peach nurseries are located, the pits are generally planted in the fall in rows 3 to 4 feet apart where the trees are to be grown. In the North the pits are sometimes stratified or bedded in the fall in moist sand, where they are under some degree of control, and the planting is delayed until spring. In either case, the action of the moisture and freezing temperatures results in the cracking of the "stones." If the pits have been stratified, the kernels are usually sifted from the stones and sand before planting. They are then handled in essentially the same manner as pits that are planted in the fall.

In very mild climates where there is little action from frosts or freezes, it is probably quite important to prevent the pits from ever becoming dry. If they are not planted as soon as they are removed from the flesh of the fruit, they should be held in such a manner as to prevent the loss of much moisture. Otherwise, a very slow and irregular germination would follow. However, pits that have become dry will frequently germinate fairly well without freezing, provided they are soaked in water for a sufficiently long time before being planted.

The usual method of propagation is by budding,[1] and the seedlings should be large enough to bud by midsummer in their first season's growth. This is done largely during July and August, extending sometimes into September. The buds put in during these months should "take," that is, become attached to the stock, within a comparatively few days if the operation is successful; then they should remain dormant until the following spring. After the buds "take," it is a common practice to "lop over" the tops of the seedling stocks by cutting them nearly off just above the point where the bud was inserted. Subsequently, the tops are entirely removed, or the tops may be left until the following spring and then removed without being previously lopped over.

The trees are ready to be planted permanently in the orchard after they have made one season's growth in the nursery. These are

[1] The operation of budding is fully described in Farmers' Bulletin 157, entitled "The Propagation of Plants," a copy of which will be forwarded without cost on application to the Secretary of Agriculture.

known as "1-year-olds," and they comprise the great bulk of the trees that are delivered by nurserymen for fall and spring planting.

A limited amount of budding is done by some nurserymen in June. Buds inserted as early in the season as this are expected to start into growth with but little delay instead of remaining dormant until the next spring, as is the case with the buds that are put in later in the summer. The trees so grown are termed "June buds" and are ready for permanent planting the following fall. While some growers plant this grade of tree with a high degree of success, the majority prefer 1-year-old trees, as already stated. Trees older than one year should not be planted unless in very exceptional instances.

In California, the stocks which are budded during the summer are sometimes used the following fall and spring for planting orchards. This practice is commonly referred to as "dormant-bud" planting.

REGIONS FROM WHICH TO OBTAIN TREES.

The section of the country from which trees are obtained is unimportant so long as the trees are well-grown, healthy, and typical of the desired varieties. The growing of good trees depends upon favorable conditions and proper management in the nursery, and these factors are not peculiar to any particular section.

The inherent qualities of a variety do not change when the trees are grown in different sections of the country. If the variety is hardy, it will continue to be so; if it is susceptible to some disease, it is not made less so by growing the tree during its nursery period in some particular region.

For economy in transportation trees should be purchased as near the place where they are to be planted as practicable. Moreover, trees shipped long distances sometimes suffer injury if they are not properly packed or if they pass through severe extremes of temperature while in transit. Other things being equal, the nearer the nursery the shorter the period during which the trees are out of the ground. On the other hand, differences in the price of trees of the same grade offered by different nurserymen, the desire to secure trees of some special varieties, or some other reason may make it preferable to purchase elsewhere than at the nearest nursery.

TREES FOR PLANTING.

As a rule, only thrifty, well-grown, well-rooted 1-year-old or "June-budded" trees free from injurious insect pests and fungous diseases should be planted. Thrifty, well-grown trees are not necessarily the largest trees which can be found in a nursery. Medium-sized trees are probably fully as desirable for planting as the larger ones, but the smaller grades in some cases may be made up of trees

that are stunted and weak from some cause or other. Not infrequently they have poor root systems. The smaller trees can usually be bought at a lower price than the medium-sized and large ones, but they may prove costly in the end, especially if they are lacking in vitality and make a poor growth after being planted.

Peach trees are commonly graded according to their height. In properly grown trees, however, there is a pretty definite relation between the height and the size of the trunk or "caliper" of the tree. The diameter of the stem is sometimes used as the basis for grading nursery stock. The grades, according to height, are designated as "3 to 4 foot," "4 to 5 foot," "5 to 7 foot" trees, etc. Figure 3 shows four trees of each of three different sizes or grades. The relative size and height are apparent. The heaviest grade (C) is composed of larger, more heavily branched trees than the smaller ones; but they are more bulky and heavier to handle, and it is a question whether they will develop into any better trees ultimately than the medium-sized grade. The smallest grade (A) is composed of fairly good trees, but some of them may be lacking in vitality. Sometimes, for the sake of reducing the first cost, a grower buys even smaller trees than the 3 to 4 foot grade, but in most cases this proves to be false economy. A few cents per tree of additional cost means comparatively little in the initial expense of starting an orchard, but it may mean a vast sum later in the life of the orchard in the better development of good, vigorous trees.

Before planting an orchard, every prospective peach grower who has important interests at stake should form an accurate conception of what constitutes good nursery trees in every respect; he should thoroughly familiarize himself with the appearance of the insects and diseases that are likely to be disseminated on nursery stock; and he should give particular attention to the character of the roots and their freedom from such troubles as crown-gall and aphis injury.

TIME OF PLANTING.

In general, in northern latitudes, or wherever the winters are rather severe, planting in the spring as early as the soil can be worked to advantage and after the danger of hard freezes is past is to be advised. But in middle and southern latitudes and in regions generally where the winters are mild and where the fall season is favorable for working the soil until late, the planting of trees in the fall is generally successful and by many is preferred to spring planting. The planting should be delayed until thoroughly well and naturally ripened trees can be obtained, but it should be done before the advent of really cold weather. Fall-planted trees should reestablish some root action in their new positions before winter sets in. The danger of winter

injury is thus reduced. But in some of the milder portions of the country, where the soil seldom freezes deep and rarely remains frozen for more than a few days at a time, peach trees are commonly planted at almost any time during the winter.

In many parts of California, after the first rains have moistened the soil, usually early in January, the planting may be done to advantage, though some soils may be too cold and uncongenial at that

FIG. 3.—Nursery stock, showing different grades or sizes of 1-year-old peach trees: *A*, 3 to 4 foot grade; *B*, 4 to 5 foot grade; *C*, 5 to 7 foot grade.

time. In such cases planting is usually deferred until early spring, though there is then some danger of the trees starting into growth before the soil reaches a suitable condition to be properly handled.

HANDLING THE TREES WHEN RECEIVED FROM THE NURSERY.

When received from the nursery the trees should be unpacked immediately. Every possible precaution should be taken to prevent the roots from becoming dry. Unless the trees can be planted im-

mediately, they should be heeled in, in a thoroughly well-drained place, where the soil is mellow and deep. A trench sufficiently wide and deep to receive the roots is made; then the trees are placed in it in the manner shown in figure 4. In covering, the soil should be worked among the roots of the trees sufficiently to fill all the spaces between them. This will fully exclude the air; otherwise, there is danger of the roots drying unduly. If a large number of trees are to be heeled in at the same place, it will usually be found convenient to place them in closely adjacent rows. When this is done, the trees in one row, for convenience, may be covered with the soil which is removed in opening the next adjacent trench.

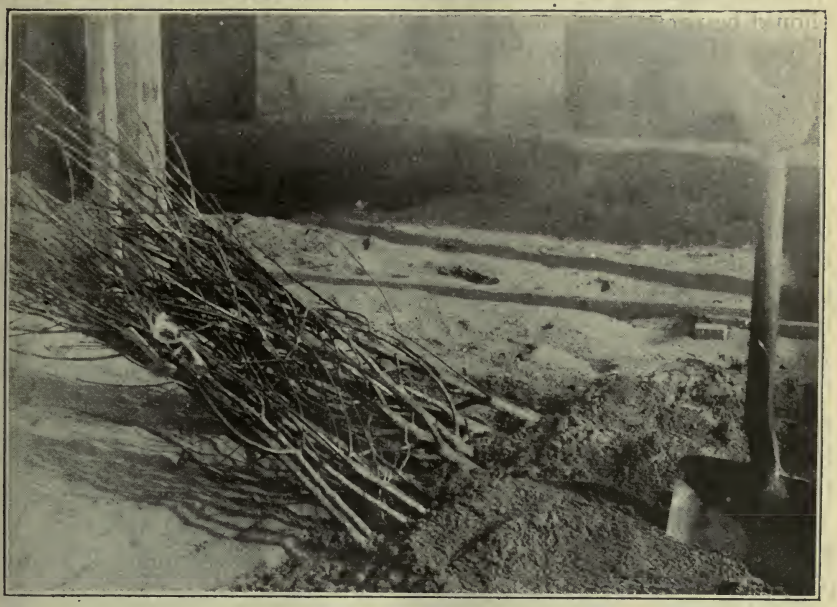

FIG. 4.—Peach trees heeled in. They may be held in this manner in good condition for a long time.

Trees that are tied in bundles when received must be separated before being heeled in. If this is not done, it is practically impossible to work the soil among the roots sufficiently well to prevent them from drying to a serious extent.

Sometimes it is necessary to leave the trees heeled in over winter. It is then well to place them in a position which is nearly horizontal, so that the entire portion of the trunks below the branches can be readily covered with soil for the purpose of protection. Such protection is of particular importance in the colder peach-growing districts. The soil should be made rather firm about the trunks and roots, so that harbors for mice will be reduced to a minimum.

PREPARATION OF THE LAND.

The ideal preparation of the soil for peach trees consists of deep plowing and thorough pulverizing with the harrow or cultivator, though a certain amount of variation from this ideal may not result disastrously. For example, where newly cleared land is to be devoted to peaches, it is practicable to remove the stumps from a narrow strip along the line of each row of trees, thus making possible a thorough preparation of the strip before the trees are planted and permitting thorough tillage throughout the following season. Each season thereafter the cleared strip should be widened and the cultivation extended. By the time the trees come into bearing, the stumps should be pretty well cleared from the entire area.

Newly broken sod land can not be as readily fitted for the planting of trees as land that has been plowed long enough for the sod to become well rotted.

PLANTING THE TREES.

Peach trees are planted at various distances apart, the topography of the land, the fertility of the soil, the varietal characteristics of the trees, and the preferences and conceptions of individual growers all being factors to be considered. Common planting distances are 18 by 18 feet, 18 by 20 feet, or 20 by 20 feet, requiring, respectively, 134, 121, and 108 trees per acre. Closer planting is sometimes practiced, but it is rarely advisable, and under some conditions 25 by 25 feet probably does not allow the trees more space than they need. The trees are usually planted in squares, as the above distances suggest, but the triangular system or some of its modifications is occasionally used.

Every reasonable care should be observed to plant the trees in straight rows and in perfect alignment in both directions. Trees so placed look better and can be cultivated better and more conveniently than where the rows are crooked and irregular.

Before digging the holes for the trees, some growers plow one or two deep furrows along the line which marks each row, thus greatly reducing the amount of digging that must be done with a spade at the points where the trees are to stand. The holes should be broad enough to admit the roots without bending or crowding them from their natural positions, and deep enough to allow the trees to be planted 2 or 3 inches deeper than they were in the nursery.

The use of dynamite in preparing the holes where trees are to be planted has been extensively advocated, but if a soil is well suited to peach growing, it is a question whether dynamiting will improve it materially. If the soil is not adapted to peaches, it is a question whether dynamiting can accomplish any permanent good. Moreover, under some soil conditions positive harm may result.

In some sections a thin stratum of hardpan or other impervious material occurs below the topsoil, while the subsoil beneath the impervious stratum is well suited to peach growing. Undoubtedly the use of dynamite as a means of breaking up such strata is entirely practicable and effective when it is properly applied.

In preparing a tree for planting, all portions of the roots which have been mutilated in digging the trees or injured by any other means should be trimmed off, and long slender roots, if they occur,

FIG. 5.—Peach trees trimmed ready to plant: *A*, 4 to 5 foot grade; *B*, 5 to 7 foot grade.

are usually cut off to correspond with the length of the general root system.

Unless a tree is rather large, the branches should all be removed, leaving only a single unbranched stem, as shown in figure 5, *A*. This stem should be headed back to correspond with the height at which it is desired to form the head of the tree. The common extremes as to height of top preferred by different growers range from about 12 to 18 inches up to 24 or 30 inches.

But if the larger grades are planted—those, for instance, which are 6 feet or more in height—it is usually safer not to trim to a single unbranched stem. There might, then, not remain enough buds which would give rise to branches properly placed to make a good symmetrical head. It is therefore wise to select from three to five branches that are well distributed about the main stem, from which to develop the head. The limbs thus selected for the foundation of the top should be headed back to mere stubs, as shown in figure 5, *B*, but on each stub there must be left at least one well-developed bud to insure a starting point for the growth of the branch. With small and medium-sized grades there is little danger that an abundant growth of desirable character will not develop from the main stem.

Danger that the roots may become too dry after they are trimmed and before the trees are planted can be largely eliminated by dipping the roots in a puddle of clay of such consistency that a thin layer of mud will adhere to them when they are dipped into it. Such a coating of mud will afford considerable protection against undue drying out from exposure to sun and wind.

In filling the hole after a tree has been put in position and properly aligned, only finely pulverized soil should be used. Much care should be taken to work the soil in closely about the roots. This may be done to some extent with the fingers. Moving the tree up and down very slightly after the first few shovelfuls of soil have been placed in the hole will also help materially to settle it among the roots.

As the filling progresses, the soil should be firmly tamped about the roots either with the feet or with some sort of a plunger. The soil around the tree should be left about even with the general level of the surrounding surface.

TILLAGE.

Tillage refers to the working of the soil after the trees are planted. The objects of tillage have been comprehensively summarized as follows:[1]

(1) Tillage improves the physical condition of the land (*a*) by fining the soil and thereby presenting greater feeding surface to the roots; (*b*) by increasing the depth of the soil and thereby giving a greater foraging and root-hold area to the plant; (*c*) by warming and drying the soil in the spring; (*d*) by reducing the extremes of temperature and moisture.

(2) Tillage may save moisture (*e*) by increasing the water-holding capacity of the soil; (*f*) by checking evaporation.

(3) Tillage may augment chemical activities (*g*) by aiding in setting free plant food; (*h*) by promoting nitrification; (*i*) by hastening the decomposition of organic matter; (*j*) by extending these agencies (*g*, *h*, *i*) to greater depths of the soil.

[1] Bailey, L. H. The Principles of Fruit Growing, p. 139. New York and London, 1897.

If the tillage is sufficient to maintain the physical condition of the soil and to conserve the soil moisture adequately, the other objects also probably will be realized. An orchard should be tilled, if at all, for the sake of the trees and their product. If without tillage the proper soil conditions exist to an extent which is adequate for the needs of the trees and the production of good crops, then perhaps nothing is to be gained by tillage.

With reference to peach orchards, there is comparatively little difference of opinion in regard to tillage. The conviction of the best growers in practically all peach-producing sections is that thorough tillage is essential to the continued successful maintenance of a peach orchard.

To one grower "thorough tillage" may mean plowing the orchard in the spring and harrowing it once or twice later in the season; to another, who has a very high estimate of tillage as a means of preventing the evaporation of moisture from the soil, it may mean going over the orchard with some tillage implement 20 or 25 times during a dry season.

Generally speaking, a peach orchard should be tilled throughout its entire life, beginning with the first season after the trees are planted. If, for the sake of economy or for other reasons, it is impracticable to work the entire area between the trees, it is usually feasible to confine the tillage for the first year or two to a narrow strip along each row. But the width of the tilled strip should be extended each season, and by the third year the entire surface should receive attention. By that time the roots of the tree extend beyond the spread of the branches and the entire space between the rows, where the trees have been planted the usual distances apart, is rapidly becoming filled with small rootlets and root hairs through which moisture and plant food in solution are taken up. The root development of peach trees, indicating the position of the roots with regard to tillage and the application of fertilizers, is suggested in figure 6.

Under normal or standard conditions in most peach-growing districts the advice applies generally, to begin the tillage in the spring as soon as the soil is in suitable condition to work. But in the case of bearing orchards, some of the most experienced growers wait until after the fruit has set before they begin, in the belief that earlier tillage may influence adversely the setting of the fruit. The presence of a cover crop, its character, and the needs of the soil with reference thereto are other factors that may influence the date of beginning of tillage. The handling of cover crops is discussed on another page.

If the soil is hard or if there is a cover crop that has made considerable growth, it will be necessary to turn the soil with a plow and

follow with a harrow, cultivator, or such other tillage implement as best suits the needs of individual orchards. If the soil is light, plowing in the spring can sometimes be omitted, as some type of cultivator will be found adequate to pulverize thoroughly the soil to a sufficient depth. The surface should be kept as nearly level as possible. For instance, if the soil is plowed toward the trees at one time, it should be turned away from them at a later plowing.

In general, the orchard should be gone over with some kind of a tillage implement often enough to keep the soil thoroughly light and

FIG. 6.—A peach tree about 5 years old growing in "Porter's red clay" soil, Virginia. The spread of the branches was 18 feet. The spread of the roots, as traced, was 36 feet—17 feet on one side and 19 feet on the other.

loose, or, in other words, in the condition of a dust mulch, for a depth of at least 3 or 4 inches. If a crust forms on the surface, or if the dust mulch becomes compact, evaporation of the moisture that is in the soil will become excessively rapid and an unnecessary and perhaps serious loss of moisture which is needed by the trees will occur. As the surface is made compact by rain, tillage is advisable, as a rule, after each rainy period or after heavy showers; also as much more frequently as the impaired condition of the dust mulch may make necessary. In irrigated orchards tillage should generally follow soon after each application of water.

Tillage operations are usually continued until midseason—the last of July or the first of August. By that time the growth of the trees

for the season will have been largely made, fruit buds for the next season's crop will have begun to form, the fruit of the midseason varieties will have completed a large proportion of its growth, and the later varieties will finish their development during a period when less moisture is required for the various functions of the tree than earlier in the season. Where cover crops or green-manure crops are desired, they should be sowed, in many cases, by this time.

As the trees become large, some of the extension types of tillage implements are advantageous, as they make possible the working of the soil under the branches without unduly crowding the team into the trees. In one of the large mountain peach orchards in West Virginia, where the broken topography of the land requires strong

FIG. 7.—An efficient outfit for the tillage of orchards where the topography is much broken and the draft is heavy.

motive power for efficient work, the outfit shown in figure 7 has proved especially well adapted. The team of leaders is driven by a "jerk line," the driver riding the near pole horse. The man who rides the harrow not only serves the useful purpose of weighting it down, so that it will cut deep, but he also guides the harrow past the trees by properly adjusting the positions of its two sections. In this way the trees are rarely injured, and yet the harrow can be run very close to them. However, in this particular orchard the use of the harrow is usually preceded by 2 or 3 bouts with a light 1-horse plow along each row of trees.

The homemade leveler shown in figure 8 is also a very useful tillage implement in some orchard districts. Though of special importance in some of the irrigated districts for leveling the irrigation furrows, it is effective in crushing clods and in smoothing the surface of the soil. It consists of two side pieces of 2-inch plank, 12 or 14 feet long

and 6 to 8 inches wide. The crosspieces are 7 or 8 feet wide. The lower edges of the crosspieces where they come in contact with the ground are protected with strips of iron or steel to prevent undue wearing and also to give increased efficiency.

MAINTAINING THE FERTILITY OF THE SOIL.

Good tillage and the maintenance of an ample supply of humus or decaying vegetable matter in the soil will do much to keep it in a sufficiently productive condition for peach growing. But continuous tillage of the soil tends to deplete its content of humus unless it is renewed from time to time.

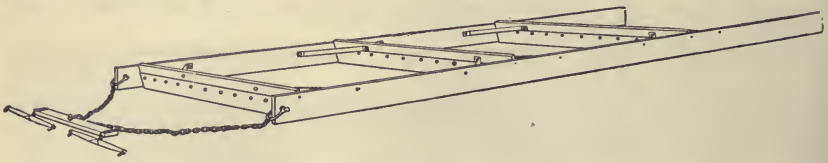

FIG. 8.—A leveler used in some sections for filling irrigation furrows, making the surface of the soil smooth, and pulverizing the clods.

USE OF COVER CROPS.

Where stable or barnyard manure is abundant there is probably no more satisfactory way of supplying humus to the soil than by a liberal use of it. Manure is seldom obtainable, however, in sufficient quantity to meet any far-reaching needs. In its absence the use of cover or green-manure crops is to be advised.

The ways in which a cover crop may contribute to the welfare of the orchard have been enumerated as follows:[1]

(1) It directly improves the physical condition of the land; prevents hard soils from cementing or puddling; holds the rains and snows until they have time to soak away into the land; dries out the soil in spring, making early tillage possible; sometimes serves as a protection from frost.

(2) It catches and holds some of the leaching nitrates, of which the roots of trees are in little need late in the season; adds humus to the soil; renders plant foods available; appropriates nitrogen, if it is a leguminous crop.

The plants commonly used for cover-crop purposes fall into two groups—leguminous (or nitrogen-gathering) and nonleguminous. The former group comprises red clover, crimson clover, bur clover, field peas, vetch, cowpeas, and others; the nonleguminous group consists of rye, oats, buckwheat, millet, rape, turnips, and various others. Sometimes the growth of weeds or other more or less spontaneous growth is encouraged after the seasonal cultivation is ended, as a means of obtaining a cheap supply of vegetable matter for the soil.

Red clover is more commonly used in apple orchards than in peach orchards, and especially when it is intended to omit tillage for a sea-

[1] Bailey, L. H. Op. cit., pp. 184–185.

son. Vetch is apparently being used more and more as an orchard cover crop in the northern fruit districts. Crimson clover is especially satisfactory in some of the light soils in New Jersey and Delaware in seasons when there is a good supply of moisture in the soil at the time of seeding. Cowpeas are very widely used for this purpose in middle and southern latitudes.

Probably rye is the most widely used nonleguminous plant. It can be sowed late in the season, and it lives over winter and starts into growth early the next spring. All of these points are important considerations in many instances. But oats in combination with vetch have been especially satisfactory in some cases, and German millet has been shown to be almost an ideal nonleguminous cover crop under some of the conditions that prevail in Nebraska.[1]

In starting the cover crop, the usual practice is to sow the seed when the orchard is given its last cultivation for the season, usually in July or early in August, though the exact time is regulated by conditions. Sometimes cowpeas are planted in drills in June and tillage continued with a small cultivator. Where rye is used, it is commonly put in toward the close of the growing season.[2]

When a cover crop is used in a peach orchard it should be plowed under as early in the spring as practicable, unless the growth that is on the ground can be worked into the soil effectively and more conveniently by the use of a disk or cutaway harrow. However, if there is an abundance of moisture in the soil, the turning under of the cover crop is delayed in many cases until after it has made considerable growth in the spring, in order to obtain as large a quantity of vegetable matter to be worked into the soil as is possible.

The use of cover crops is sometimes limited in particular seasons by lack of moisture. If there is a protracted drought at the time the seed should be put in and the trees are suffering therefrom, it might do more harm than good to make a further demand upon the moisture in the soil by sowing a cover crop, even though the soil may be known to lack humus.

In certain districts of generally low precipitation in which peaches are being grown successfully, continuous clean tillage, with the return of practically no vegetable matter to the soil, is bringing the ground into poor physical condition. Stable manure as a source of humus is not to be had in sufficient quantity to be of any real value, and the limited moisture supply is not sufficient to maintain the

[1] Emerson, R. A. Cover crops for young orchards. Nebr. Agr. Exp. Sta. Bul. 92, 93 p. 12 fig., 1906.

[2] The amount of seed of the various cover crops commonly sowed per acre is as follows: Red clover, 10 to 15 pounds; crimson clover, 12 to 16 pounds; bur clover, 20 pounds; field peas, 1½ to 2 bushels; vetch, 1 bushel (60 pounds); cowpeas, 1 to 2 bushels; rye, 1½ to 2 bushels; oats, 2 to 2½ bushels; buckwheat, one-half to 1 bushel; millet, 1 to 1½ bushels; rape, 3 pounds; turnips, 3 pounds.

peach trees and grow a cover crop at the same time. This situation as it exists in some districts presents serious problems. The growers are beginning to realize its import.

Likewise in some irrigated districts where the water supply is limited, the need of a cover crop may have to be disregarded, either habitually or in seasons of unusual water shortage, because there is not enough moisture to meet the demands of both the trees and the cover crop.

Aside from maintaining the fertility of the soil, cover crops may have important functions in other respects. Where the soil is subject to washing, a cover crop which survives the winter will often prevent or materially lessen the washing that would otherwise occur.

If good tillage and the wise use of cover crops fail to produce the best results in a peach orchard that is well situated, the use of commercial fertilizers may then logically receive consideration as a last resort.

USE OF FERTILIZERS.

There is no "best" fertilizer for peaches, and no particular fertilizer can be recommended. A fertilizer which is economical to use and which gives maximum results in a particular orchard might be without appreciable effect in another orchard.

In maintaining soils in a highly productive condition it is important to learn what factors are limiting the performance of the orchard. The limiting factor may be an insufficient supply of some kind of plant food, improper physical condition of the soil due to a lack of humus or poor drainage, or it may be something else. The real problem is to determine what the trouble is and then apply the proper remedy, if it is known.

Fertilizers are often largely without appreciable effect if they are applied to soils that are in poor physical condition, as when they are greatly lacking in humus. For this reason attention should be given to the use of fertilizers only after the possibilities of tillage and the maintenance of the soil in good physical condition have been exhausted.

It follows that a complete fertilizer may give excellent results. But if there is an insufficient supply of only one plant food, then it may be assumed that the response from the fertilizer is due to the presence in it of that plant food of which there was an insufficient supply in the soil and that the other plant foods in the fertilizer were without any real value to the crop or trees. Obviously under such conditions a complete fertilizer would not be economical.

The wiser plan is to carry on a few experiments with a view to determining local needs. A representative portion of the orchard may be selected. To a few trees—perhaps 5 or 6—nitrogen may be

applied; to other trees, potash; and to still others, phosphoric acid. Different combinations of these plant foods, including one which has all of them, thus making a complete fertilizer, may be applied to other groups of trees.

If a detailed record is made of the different applications and each group of trees treated the same way each season for several successive years, gradually the results of the different fertilizer treatments will become apparent in the behavior of the trees, their growth and vigor, the productiveness and regularity of the crops, the quality of the fruit, and in other ways. From such results the grower who has carefully studied the conditions should be able to decide upon a rational basis for the use of fertilizers in his own orchard.

IRRIGATION.

Most of the peaches produced in the Intermountain States and west of the Rocky Mountains are grown under irrigation. It is not feasible, however, to discuss the details of irrigation in this bulletin. Attention is called to Farmers' Bulletin 882, entitled "Irrigation of Orchards," which will be forwarded without cost by the Division of Publications, United States Department of Agriculture.

PRUNING.

As a general proposition the most successful fruit growers habitually prune their trees, and in doing it they usually follow more or less closely some plan or system, even though they may have no clear-cut conception of just what their plan involves.

The principal objects sought in pruning may be summarized as follows:

(1) To modify the vigor of the tree.
(2) To keep the tree shapely and within bounds.
(3) To make the tree more stocky.
(4) To open the tree top to admit air and sunshine.
(5) To reduce the struggle for existence in the tree top.
(6) To remove dead or interfering branches.
(7) To renew the vigor of the tree.
(8) To aid in stimulating the development of fruit buds.
(9) To secure good distribution of fruit buds throughout the tree.
(10) To thin the fruit.
(11) To induce uniformity in the ripening of the fruit.
(12) To make thorough spraying possible.
(13) To facilitate the harvesting of the fruit.

The pruning which a tree receives during the first two or three years after it is planted has much to do with its future. Mistakes in forming the head or the results of neglect during the early years in

FIG. 9.—A peach tree of the Muir variety during its first season's growth. The cross lines shown in the figure are intended to suggest suitable points at which to cut the branches when the pruning is done later on. (Photographed in California, Aug. 27, 1913.)

the life of a tree are practically irreparable. On the other hand, if the tree is well formed and properly pruned during its first years, the foundation for a good tree is established; subsequent errors in pruning, if they occur, may admit of correction without permanent harm to the tree.

In general, the proper time to prune peach trees is during the dormant period, preferably in late winter or early spring, just before growth starts, except in regions where bleeding from wounds is likely to occur. In such regions it should probably be done in early winter. But conditions and the object of the pruning must be considered in each case. If the pruning operations are very extensive, it may be necessary to prune throughout the winter whenever the weather is suitable for men to work in the orchard. If the fruit buds are endangered during the winter by adverse temperatures, it may be advisable to delay pruning as much as economic conditions permit until settled spring weather arrives. This is especially advisable if heavy heading back of the previous season's growth is desirable for the sake of the tree, since if a large proportion of the fruit buds are killed it may be best for the prospective crop not to cut back heavily.

A limited amount of summer pruning can usually be done to advantage. The trees should be observed constantly throughout the season of active growth. Whenever a branch is seen to be so placed that it obviously will need to be removed at the annual pruning for the shaping up of the tree, it is well to take it off at once. In this way the annual pruning can be reduced to a minimum and the removal of large limbs will rarely be necessary.

Then, too, it frequently happens that a single branch in the top of a tree will grow considerably faster than any of the others, making the tree unsymmetrical if the growth of the branch is not checked. A slight heading in as soon as such a tendency is apparent will usually keep the top well balanced.

The pruning of a peach tree at the time of planting it has already been discussed. A tree well along in its first season's growth is shown in figure 9. It will be observed that the top is formed of four main branches. This tree shows evidence of having received attention during the earlier part of the season. Only those branches which were of importance in forming the top have been allowed to develop. The exact number of branches which may be used in forming the head is not an arbitrary matter. From three to five branches are permissible, if they are well placed and properly distributed on the main stem of the tree. The branches that form the head of the tree shown in figure 9 start from points on the trunk which are rather too close together. If there was more space between the branches where they join the trunk there would be less danger of the limbs breaking down in later years from the weight of heavy loads of fruit.

During the dormant period between the first and second year, the first year's growth, provided it has been thrifty and vigorous, should be headed back rather heavily; perhaps one-half or two-thirds of the growth should be removed. The cross lines shown in figure 9 suggest suitable points at which to cut the branches when the pruning is done later on. However, this needs to be considered with several things in view: The symmetry of the tree, its strength and vigor, and its future development. In order to provide for an open, well-formed head in later years, it may be necessary to thin out some of the smaller, secondary

FIG. 10.—Peach trees about 3 years old that have not been headed in. The limbs are slender and will probably break badly with the weight of the first good crop of fruit.

FIG. 11.—A peach tree that has been badly pruned. The bearing wood is near the extremities of the limbs. The weight of even a small crop of fruit would be likely to break the limbs to a serious extent.

branches. In doing this, however, provision must be made for a uniform distribution of limbs so spaced that the open top desired will be insured and yet the main limbs still carry an ample number of secondary branches.

Pruning the second and third years does not differ in principle from that which follows the first season's growth. At each pruning the previous season's growth is headed back, though perhaps not quite as much as at the first pruning. This, however, will depend upon the character of the growth and the condition of the tree. If it is stocky and strong, less heavy heading back will be required to serve the end in view, but long, slender, spindling growth should be shortened back as severely after the second or third season as at the earlier pruning.

At each subsequent pruning the secondary branches require the same attention as at the first pruning. The points which require particular attention are thinning out enough to keep the top open and shortening in heavily in order to produce a new growth of bearing wood evenly distributed throughout the top of the tree and on the interior surfaces of the main limbs.

The effects of not heading in are shown in figure 10. The trees here shown are making their second or third season's growth. They were not well headed in at first, and no heading back has been done since they were planted. Besides, the soil is lumpy and in poor tilth, and the trees are making a weak, slender growth. Had they been well headed back, the growth would have been much more stocky, even though the trees were small, and they would be in much better condition to sustain the weight of a crop of fruit than they can possibly be under the system of management that has been followed.

The tree shown in figure 11 has been pruned more or less, but it exhibits serious defects. It has not been well headed back, the top

has not been properly opened, and the smaller, secondary growth has been entirely pruned from a considerable portion of each of the main limbs instead of being utilized to develop fruit-bearing branches in the center, where its weight can best be supported without breaking the tree. With the bearing wood largely developed toward the outer extremities of the branches and the size of the branches disproportionately small for their length, even a small crop of fruit would be likely to break the tree to pieces very badly. This tree may well be contrasted with the trees shown in figures 12 and 13, which have been pruned with a view to developing the characteristics referred to. The limbs are stocky and well proportioned for sustaining heavy crops of fruit. The interior of the trees is well filled with bearing wood and at the same time the tops are sufficiently open to admit a full quota of sunshine to practically all the fruit.

By the time peach trees are 3 or 4 years old they should be bearing good crops of fruit. After this, they will make a smaller annual growth under usual conditions than during the earlier years. Less heading in is therefore required. In some seasons it may not be necessary to cut back the terminal growth, though to do so will tend, as a rule, to develop the smaller secondary and side branches. This is

FIG. 12.—A Levy peach tree 8 years old pruned with a view to developing strong, stocky branches and an open top. (Photographed in California, Aug. 28, 1913.)

FIG. 13.—Phillips peach trees 10 years old. These trees have been systematically headed back, and strong, stocky limbs have developed. It is necessary, however, to prop them when very heavily loaded with fruit. (Photographed in California, Aug. 27, 1913.)

desirable, for reasons already mentioned. Again, the extent of the heading back will be governed in some seasons by the abundance and condition of the fruit buds. If there has been winter injury or if the buds failed to form well the previous season, little or no reduction of the previous season's growth will be needed. On the other hand, if the trees made a strong growth, an abundant set of fruit buds developed, and they have suffered no injury, a correspondingly heavy cutting back of the previous season's growth may be advisable in order to thin the fruit as much as is possible by that means.

Peaches are always borne on wood that grew the previous season. Therefore after a peach tree reaches bearing age it is essential so to manage it as to induce a fairly liberal growth each season.

As a general proposition, very heavy pruning will induce a correspondingly large amount of new wood growth. It follows that the weaker-growing varieties should be pruned more heavily, relatively, than the very strong-growing sorts.

Some of the details of pruning mature peach trees are suggested in figures 14 and 15, which show a tree 8 years old before and after it received the annual pruning to make it shapely, remove superfluous wood, and provide for the development of new growth. While the tree illustrated is far from being ideal, as it had not been well

handled in previous years, it shows certain important features. The heading back of the main limbs will tend to prevent them from becoming "leggy," and it will induce a good, strong growth of new fruit-bearing wood well within the center of the tree. It may require some thinning out at the next annual pruning to prevent the top from becoming too dense. Probably more wood of the previous season's growth should have been left than is shown in figure 15, as there appears to be only a small amount of surface on which fruit can be produced the following season; but apparently the tree has been put in fairly good condition with regard to its later usefulness.

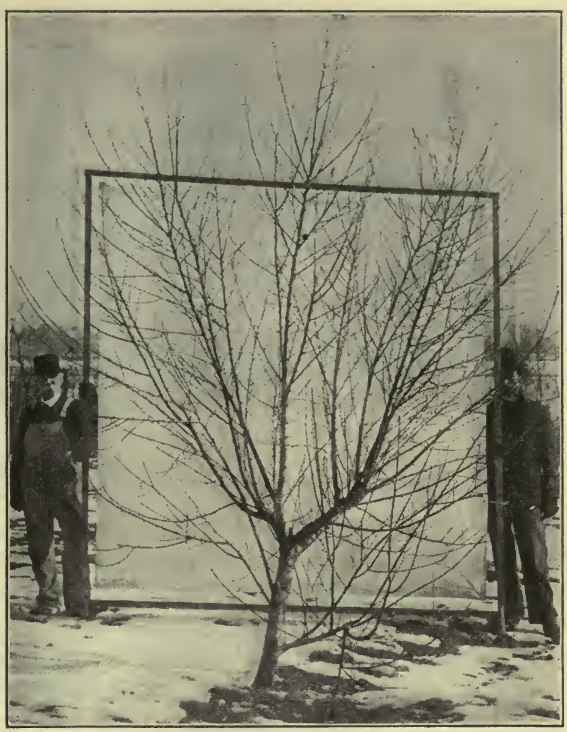

FIG. 14.—A peach tree about 8 years old, before pruning.

FIG. 15.—The same tree shown in figure 14 after being pruned.

The growing of an open-headed tree is not merely a matter of keeping the top well thinned out. The position of the branches can be controlled and directed to a marked extent by the manner in which the pruning is done. Figure 16 shows two Elberta trees which have a rather remarkable

FIG. 16.—Elberta peach trees 14 years old which have been pruned with a view to producing open, spreading tops. The branches of the two trees together in the foreground have an expanse of about 55 feet. (Photographed in Colorado, Aug. 23, 1910.)

spread of limb. Systematic pruning and heading in were practiced in the earlier years of these trees. The spreading habit has been augmented by cutting the branches to outside buds when they were headed back. The significance of this is more clearly shown in figure 17, which was drawn from life. When the branch was cut back at *b*, during the winter following its growth, the bud nearest the end of the stub was on the outside of the limb. When the branch *b c* developed from that bud the following season, it made a decided angle with the one *a b* on which it developed, thus changing the direction of the growth from that which would have followed the extension of the limb *a b* had it not been cut back and resulting in a considerable widening of the spread of the branches.

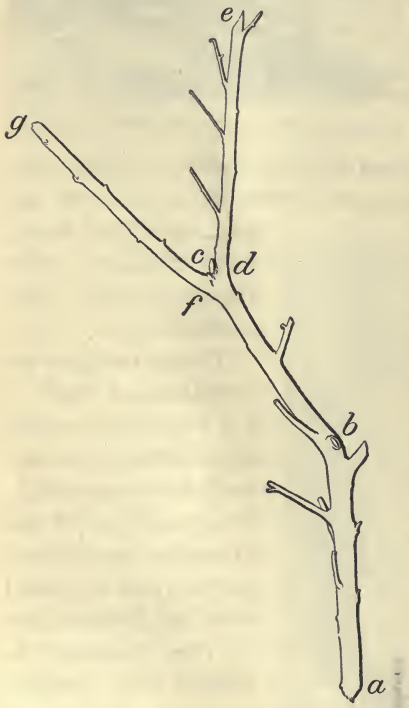

FIG. 17.—A branch which suggests the possibilities of influencing the habit of growth by the position of the bud left at the end when the branch is cut back.

The following season, when the pruning was done and the limb *b c* was cut off at *c*, the outermost bud was nearly on top of the stub at *d*. When this bud gave rise to a branch *d e*, the limb *b c* was continued thereby in approximately the direction of the older limb *a b*.

The limb *f g*, which developed from a bud at *f* which was not as near the end of the stub as was the bud at *d*, did not materially change the direction of the branch *b c*. Had the bud at *d* been on the outside, the spread of the branch would have been still more widened, as was the case when the branch *b c* grew from *b*, the latter being an outside bud. If it is desired to correct the habit of growth in the case of a tree that is too spreading to be desirable, cutting back the limbs to inside buds will tend to accomplish the end in view.

Heading in a tree from year to year as suggested, and pruning with a view to producing an open, spreading, low top results not only in the development of strong, stocky limbs well able to sustain heavy loads of fruit, but it brings a large proportion of the top near the ground, where much of the fruit can be harvested without the use of stepladders.

The man who prunes a fruit tree during its first years must have a pretty clear conception of what the tree is to look like when it reaches maturity, and he needs to know from the beginning what is necessary each time it is pruned in order to develop the tree which forms his mental vision. A well-formed plan, based on a knowledge of the underlying principles of pruning, is essential if the operation is to be anything more than a haphazard removal of branches that appear to be in the way.

FIG. 18.—Pruning Salwey peach trees in an Allegheny Mountain orchard in West Virginia.

FIG. 19.—A sled used for hauling brush from an orchard. (Photographed in West Virginia.)

Figure 18 shows a type of stool that is used in one of the Allegheny Mountain peach orchards both in pruning the trees and in harvesting the fruit. The legs spread enough to make the stool stand firm and to give the workman a sense of security when standing on it. When intended for use in an orchard that is located on a very steep slope, the two legs on one side of the stool are made somewhat shorter than those on the other side.

A sled similar to the one shown in figure 19 is very convenient under some conditions for removing the brush from an orchard after it has been pruned. Another way of disposing of the brush is shown

FIG. 20.—A wagonlike device in which the brush pruned from trees is burned as it is drawn through the orchard. (Photographed in California.)

FIG. 21.—A peach tree 8 years old in which the new growth, i. e., the fruit-bearing wood, has been made largely at points far remote from the main limbs.

in figure 20. This device consists of a frame made of piping and lined with sheet iron. It is mounted on iron or steel wheels. The brush is thrown into it and burned as it is drawn through the orchard.

RENEWAL OF THE TOPS.

If a peach tree is neglected as to pruning during its early years and the branches are allowed to become long and slender; if, as it attains considerable age, the bearing wood, in spite of the

FIG. 22.—The tree shown in figure 21 after being deheaded.

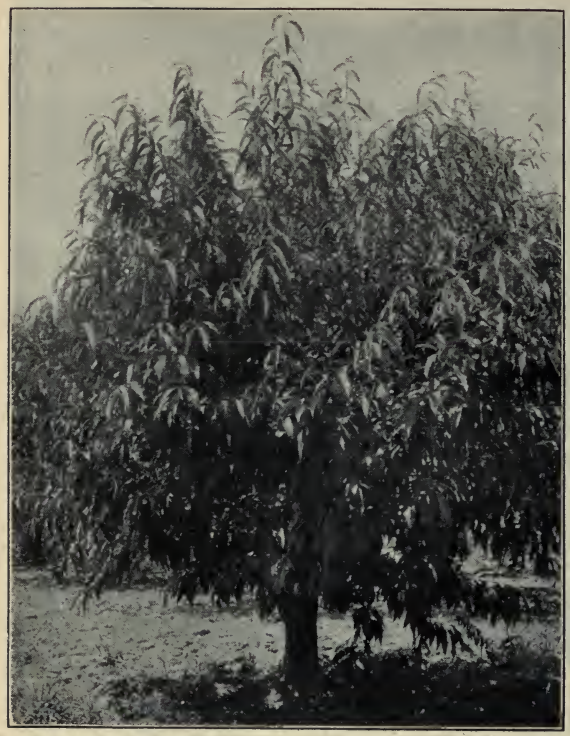

FIG. 23.—The tree shown in figures 21 and 22 during its second season's growth after being deheaded.

pruning which it has received, has grown out of convenient reach in harvesting; or, if for other reasons it becomes desirable to renew the top of a tree, it is usually entirely practicable to do so, provided the trunk and main limbs are sound and healthy. Renewal of the top will often result in prolonging the usefulness of a peach tree for several years. This operation is exemplified by several of the accompanying illustrations. Figure 21 shows an 8-year-old peach tree which has become rather "leggy." The annual growth for several seasons has nearly all been made near the extremities of the limbs. Very little new wood has grown in the interior of the tree.

Figure 22 shows the same tree after being severely headed in, or "deheaded," with a view to developing a new top. The small branches which remain on the stubs of the old limbs are an advantage, as they will start into growth more readily than the latent buds from which the new top would have to develop in the absence of small branches of recent growth.

Figure 23 is a third view of the tree shown in figures 21 and 22, well advanced in its second season's growth after being deheaded. This particular tree was somewhat lacking in vigor, and its growth following the treatment for the renewal of the top was not as satisfactory as it otherwise would have been. Figure 24 shows a 7-year-old Elberta tree which was thrifty when it was headed back to about the extent indicated in figure 22. The illustration shows this tree near the end of its first season's growth after being deheaded. It should bear a crop of fruit the next season.

If a tree which lacks vigor is treated in this way, the results shown in figure 25 may occur. Some of the stubs had no buds strong

enough to develop; hence, the top was only partially renewed. If the tops are cut back to wood that is not more than 3 or 4 years old, a stronger, more symmetrical growth may be expected than where the stubs left in deheading are older. Occasionally, where the trunk remains sound and retains its vigor, the tops are renewed two or three times. As a rule, however, it is impracticable to dehead for renewal more than once.

Sometimes, when for any reason it is desirable to renew the top of a comparatively young tree, the heading in may be made much more severe than that suggested by figures 22 and 25. This is shown in figure 26, where all the branches have been cut back to the trunk of the tree.

The season for deheading to renew the top is the same as that for doing the annual pruning for the shaping of the trees and the removal of superfluous wood—that is, during the dormant period.

When the vigor of peach trees has been well maintained by good cultural methods, suitable pruning, and wise management in every respect, their life of commercial usefulness is generally from about 8 to nearly 20 years after the full-bearing age is reached. It varies widely, however, under different conditions. In some sections, it is rarely profitable to continue them after they reach the age of 12 to 15

FIG. 24.—An Elberta peach tree 7 years old that was deheaded about as indicated in figure 22, showing its first season's growth after being cut back. It should bear a crop of fruit the following season. (Photographed Aug. 15, 1911.)

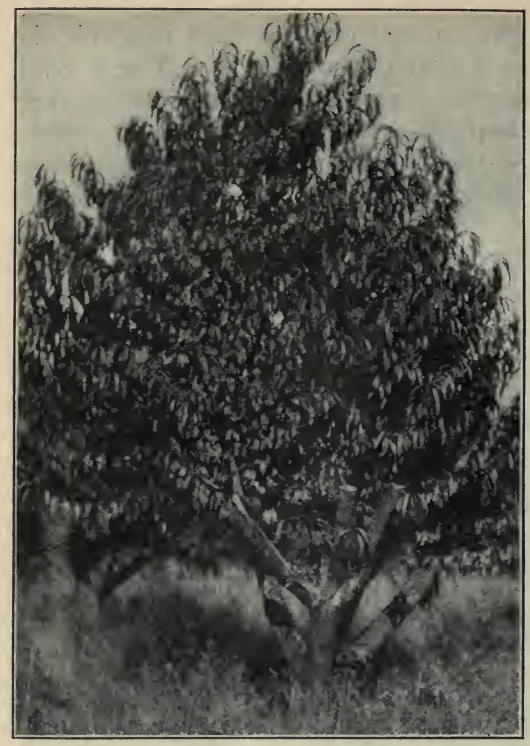

FIG. 25.—A peach tree that has been deheaded, but which did not develop a symmetrical top because some of the stubs had no buds strong enough to develop branches.

years; in others they are expected to last until they are from 15 to 18 or 20 years old, while occasionally an orchard 20 to 25 years old is found which is still of commercial value. Instances of individual trees remaining productive until a much greater age are not uncommon, but they seldom, if ever, represent orchard conditions.

CHANGING THE TOP BY BUDDING AND GRAFTING.

Sometimes it is desirable to change the top of a peach tree from one variety to another. A grower may find after his orchard begins to bear that he has a larger number of trees of some variety than he wants; a block of trees may prove to be some other variety than the one ordered; or, for some other reasons, a variety is not well adapted to the needs of the owner. In such cases he may top-work the tree either by budding or by grafting it to a desirable variety.[1]

The ordinary method of shield budding is most commonly used for this purpose. If the tree to be top-worked is not more than two or three years old it is usually practicable to insert the buds directly into the main limbs well down toward the point where they leave the trunk. This is illustrated in figure 27, which shows a Triumph peach tree that was budded to the Carman variety when it was 3 years old, after its crop of fruit had been removed. The points where the buds were inserted are shown in the figure.

If the tree to be top-budded has reached the age when the bark on the main limbs has become too thick and firm to be manipulated

[1] The operations of budding and grafting are fully described in Farmers' Bulletin 157, entitled "The Propagation of Plants," which will be forwarded without cost on application to the Secretary of Agriculture.

readily for budding, it is necessary first to head it back somewhat, as when the top is to be replaced with new growth of the same variety, and later insert the buds on the new branches that develop after the tree has been deheaded. When this course is followed, the buds should be inserted in the new growth as near the trunk as is practicable, in order to have as large a portion of the top as possible of the new variety. This is also desirable on account of the subsequent management of the tree.

Top-working is sometimes done by grafting instead of budding, the ordinary cleft graft being generally used. However, budding is to be preferred, especially as the wounds made in grafting do not heal readily in the case of the peach, though when properly done the union of stock and scion is generally strong enough to make a fairly serviceable tree. But troubles resulting from difficulties in the healing of the wounds are likely to occur.

THINNING THE FRUIT.

Most varieties of peaches, as well as other fruits, for that matter, under favorable conditions often set much more fruit than the tree can possibly develop to a good degree of perfection for commercial purposes. The natural tendency of the tree is to perpetuate its kind. To this end, left to itself, it develops the largest possible number of seeds, with each seed possessing the possibility of a new tree.

The grower's aim, however, is for the tree to produce the largest possible amount of fruit that can attain the highest commercial standard. The effort of the tree and the object desired by the grower tend to impose incompatible requirements. The development of a great number of

FIG. 26.—A peach tree that shows the possibility of developing an entirely new top when the limbs are cut back to the trunk. This is not likely to be successful except on comparatively young trees.

FIG. 27.—A 3-year-old Triumph peach tree top-budded with the Carman variety after harvesting the season's crop of fruit. This shows the tree about one year after the Carman buds were inserted at *a*, *b*, *c*, and *d*.

seeds is a tree-exhausting process. This is opposed to the development of large fruits. To meet his ends in this respect, the grower has recourse to thinning the fruit.

Perhaps no operation in the production of peaches requires keener judgment than thinning the fruit. No fixed rules for it can be given. A common practice, very generally applicable, is to thin so that the fruits will not be nearer together than 4 to 6 inches. But the strength of the tree, the fertility of the soil, and especially the soil moisture, together with the size of the crop (or, in other words, the number of fruits allowed to develop on the tree), govern very largely the size and perfection of the individual fruits.

Obviously, a vigorous tree growing under favorable conditions as to moisture, plant food, etc., can develop a larger number of fruits to good size than can a weak tree, or even the same tree when there is a marked deficiency either in the supply of moisture or of plant food.

The skill of the grower is shown in his ability to adjust the size of the crop on his trees to the conditions of the season. He can reduce the number of fruits on the trees if the season becomes very dry as it progresses. Thus the grower should aim to control the size of the individual fruits by thinning and by tillage and pruning.

While thinning may cost a relatively large amount per tree, actually more high-grade fruit is produced, as a rule, on a tree which bears only a moderate crop than on one which is heavily overloaded, and the average fruit on the tree with a moderate crop is of better grade than the best fruit on an overloaded tree.

The thinning should be done after the "June drop"—which usually occurs from a month to six weeks after the blossoming period, when the imperfectly fertilized and other weakly developed fruits drop off—and before the pits begin to harden. After the "June drop" is over there is very little dropping of the peaches. Hence,

practically all the fruit which remains then will be on the trees at harvest time. It will have to be picked then, anyway. It probably costs considerably less to pick a portion of the crop in June or July and drop the fruit on the ground than to pick it later and put it in a basket, where much of it will have to be handled over several times in grading and packing and then finally large quantities discarded as culls because the fruits are so small. Moreover, the fruit on an overloaded tree will sometimes ripen less uniformly than on a tree that has a moderate crop.

As the development of its pits is an exhaustive process, the limiting of the number of fruits tends to conserve the vitality of the tree. A large portion of the flesh of the peach is water; hence, if the soil is well supplied with moisture the development of the edible portion of the fruit makes a relatively light demand on the strength of the tree.

CONTROL OF INSECT PESTS AND FUNGOUS DISEASES.

After a grower has pruned intelligently, tilled and fertilized his orchard well, and irrigated it if required, the orchard may be short lived and the crops financial failures if he neglects to give proper attention to the control of insects and diseases, a considerable number of which are to be found pretty nearly everywhere in the sections where peaches are grown.

Emergency matters should be referred to the agricultural experiment station of the grower's State without delay.

Inquiries relating to any phase of fruit growing may also be referred at any time to the United States Department of Agriculture, where, without cost, through the department's experts, as full information relative to the problems as can be given may be obtained.[1]

GROWING CROPS BETWEEN THE TREES.

Frequently some annual crop is grown between the trees during the first two or three seasons to help meet the cost of maintenance during the unproductive age of the orchard. This practice is seldom any advantage to the trees in comparison with thorough tillage by itself, but if the crops are wisely selected and properly managed they are not likely to do any serious harm.

The crop ought to be one which needs essentially the same tillage that the peach tree should have, so as not to interfere seriously with that operation. But the grower should realize that he is, in effect, following a system of double cropping and that because of the crop between the trees he may need to give more attention to maintaining the fertility of the soil than he would for the peaches alone.

[1] Farmers' Bulletin 932, entitled "Spraying Peaches for the Control of Brown-Rot, Scab, and Curculio," obtainable from the Department of Agriculture on request, is of value to peach growers who have these troubles to combat.

After the trees reach bearing age they should not be made to compete with another crop. Even if the plant food in the soil is sufficient to produce successfully two crops at the same time, the peach trees usually will need all the available soil moisture, except, of course, in sections where irrigation is practiced and the supply of water is adequate for all purposes. Besides, a crop between the trees would be likely to interfere with the spraying of the trees (if the operation should be necessary), with the harvesting of the fruit, and in other ways.

Muskmelons, beans, peas, cabbages, tomatoes, and other truck crops are extensively grown between peach trees in different sections. Potatoes are sometimes used, but they are suitable only when the crop can be so managed that the digging of the potatoes will not amount to a late cultivation, which may be attended with undesirable results. Corn, also, is frequently used, but as very often managed it is objectionable, because it shades the trees excessively. Whenever corn is used, an open strip of considerable width should be left along the rows, so that the trees will be fully exposed to the sunlight throughout the season. If a very tall, strong-growing variety of corn is used, a wider strip should be left unplanted than where a dwarf variety is selected.

Peach trees are sometimes used for planting between trees, especially where apples comprise the permanent crop. This practice is highly recommended by some and emphatically condemned by other fruit growers of wide experience. It is probably objectionable in that for a period of years both bearing and nonbearing trees occupy the same area, and it is sometimes desirable to treat a fruiting tree very differently from one that is not fruiting, for the best results with each. On the other hand, where a site is particularly favorable for both fruits, a compromise treatment can often be effected which yields fairly satisfactory results with both kinds of trees.

ORCHARD MANAGEMENT AND WINTER INJURY.

In nearly all of the experiment-station bulletins on peach culture, in current horticultural literature, and in the standard works in which peach growing is discussed in detail, emphasis is habitually placed upon the necessity of so managing the orchard that the trees will cease growing and the wood become fully mature before the advent of cold weather. Otherwise, serious winter injury is anticipated. To accomplish this end it is generally advised to cease tillage in July or early August, to withhold fertilizers rich in nitrogen, and to avoid excessively fertile soil in selecting sites for peach orchards.

Undoubtedly such advice is perfectly sound and applicable to a large proportion of the peach-growing districts, but there appear to

be some rather marked exceptions that are applicable in important peach-growing sections, to which the reader's attention may well be directed.

These exceptions to the general practice have been brought to light largely through investigations carried on by the Missouri Agricultural Experiment Station.[1] They consist primarily in so managing the orchard as to maintain the trees in active growth until rather late in the season. This may be accomplished by continuing the tillage later than is ordinarily advised, by using a nitrogenous fertilizer, or by heavy pruning, which results in a vigorous growth of new wood. Any condition that seriously reduces the vitality of the tree tends to make the tree, especially the fruit buds, susceptible to injury by winter temperatures. The production of an excessive crop of fruit is a common cause of depleted vitality. The conclusions of the Missouri experiment station tentatively summarized are as follows:[2]

Where nitrogen was applied to peach trees a good crop was produced and harvested. On plats receiving no fertilizer there was practically no crop. There was likewise a failure of peaches in the surrounding region where no fertilizer was applied. The cold winter of 1911–12 was disastrous to peach trees in Missouri. Injury to peach trees caused by the cold so weakened their vitality that disease like the bacterial shot-hole leaf disease was common. On the plats fertilized with nitrogen there was little bacterial disease. On adjacent unfertilized plats the injury from this cause was very great. The trees in the plats fertilized with nitrogen also recovered from winter injury much more successfully and quickly than unfertilized trees in the same locality.

The application of phosphorus and potassium either singly or in combination did not result in increased yields. The results of the investigations on fertilizers for peaches seem to indicate clearly that a nitrogenous fertilizer or a method of cultivation and management which favors a vigorous tree growth when combined with pruning, spraying, and thinning fruit on overloaded trees will increase the crop. The above treatment tends to make them carry their fruit buds through winter and frosts of spring much more safely than where an average or weak growth only is secured. Our results seem to disprove the theory that trees must make their main growth early in the season and then be checked or retarded in their growth in August or September in order to ripen their wood before going into winter. In some experiments at this station where the trees have been encouraged to grow vigorously right up until some of the green leaves froze on the trees, either by the use of fertilizer or by severely pruning back the winter before or by thinning the fruit, they have uniformly carried their fruit buds through the winter much more safely than with trees that shed their leaves and ripened their wood early.

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[1] Missouri Agricultural Experiment Station Bulletin 74, entitled "The Winter-Killing of Peach Buds as Influenced by Previous Treatment."

Missouri Agricultural Experiment Station Circular of Information 31, entitled "Hardiness of Peach Buds, Blossoms, and Young Fruit as Influenced by the Care of the Orchard," being a reprint from the Annual Report of the Missouri State Board of Horticulture, 1908.

Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912.

[2] Missouri Agricultural Experiment Station Bulletin 111, Report of the Director for the Year Ending June 30, 1912, pp. 247–248.

A very careful correlation of these results with the conditions which are generally considered essential in the growth of peach trees in the northern districts is necessary in order to understand their significance. There is no real conflict or lack of harmony in the methods advised for the different regions, though in the abstract they may appear to be directly incompatible.

On the other hand, they illustrate very forcefully the fact that the blind application of definitely stated rules is likely to work disaster. The importance of intelligently adapting the methods used to the conditions which have to be met in different fruit-growing regions is emphasized.

The differences in the conditions in the northern peach districts and in those met in connection with the investigations of the Missouri experiment station are largely differences in the climate during the winter season.

In the northern districts the normal winter is continuously cold and without any warm spells of sufficient duration to affect the dormancy of the trees. It usually remains cold until winter finally breaks. When it warms up enough to start the trees into activity and cause the buds to swell, there is comparatively little danger thereafter of serious frosts or freezes. Moreover, the critical factor—the one which largely governs the management of the orchard in the present connection—is low winter temperatures which are sufficient to kill the buds or injure the trees even when they are perfectly dormant. To best meet this low-temperature factor, it is recognized that the trees must be thoroughly dormant and the current season's growth well ripened.

In regions where the Missouri methods are applicable, critically low winter temperatures are of little concern, provided the trees are in a dormant state. But the winters are characterized by warm spells in December, January, and perhaps in February, which are sufficient to start the buds. This makes them tender and susceptible to injury later in the season by temperatures that are entirely seasonable and which would be of no concern to the peach grower if the buds were dormant. The trees often blossom early and before the season of spring frosts is past.

The reason for continuing the growth of the trees until late in the season in these regions is based on the fact, the practical importance of which is shown in the investigations referred to, that the rest period, or period during which the trees normally remain dormant, is one which by nature continues for a fairly definite period of time. Until that period is past, when once they have become dormant, the trees do not respond readily to temperatures which later would cause them to resume a more or less active condition and might result in the buds swelling enough to make them tender.

This is a matter that is relatively unimportant in regions where the entire winter season is normally characterized by temperatures which are not sufficiently high to affect vegetation, but it has a very important significance in the regions in which warm periods of considerable length occur during the winter. If all the agencies which tend to stimulate the growth of the trees are discontinued relatively early in the season, the trees will cease growing and begin to ripen their wood at a correspondingly early date; the resting period inherently required by the trees is then completed early in the winter. If a spell of warm weather occurs soon after that period is ended, as, for instance, in January, the trees will respond to it; the buds will begin to swell and soon become tender. On the other hand, if the growth of the trees is continued actively by means of late tillage, nitrogenous fertilizers, or in other ways, until the near approach of cold weather, the period of rest and dormancy inherently required by the trees is not completed until a correspondingly later time in the winter. Under these conditions the trees remain inactive during warm spells in December or January, and the buds do not swell enough to become tender until many of the dangers incident to adverse winter temperatures are past.

While the application of these methods, which have in view the results that follow the continuation of active tree growth until late in the season, may be somewhat restricted, they are undoubtedly worthy of the most careful consideration by peach growers who are located in regions where the winters are characterized by warm periods of sufficient length to cause the trees to become more or less active before settled spring conditions arrive.

There are a few special methods and practices in the management of peach orchards which are of sufficient importance in some sections to justify brief reference to them here.

The Ohio Agricultural Experiment Station has called attention to the efficacy of slightly mounding up the soil about the base of the trees in preventing injury during periods of excessively low winter temperatures. In the same connection it has been shown that various other factors relating to the soil may greatly influence the amount of damage which peach trees suffer during such periods.

The winter of 1903–4 was characterized in the Lake Erie peach district of Ohio by periods of severe and prolonged cold. Great numbers of peach trees were killed. The prevailing conditions and their attendant results on the peach trees are summarized as follows:[1]

Exceptional causes of susceptibility to cold in rare cases of apparently healthy, vigorous trees: Low, moist, rich black soil which favored an extreme growth of soft, poorly ripened, or matured wood; or high culture upon soil rich in plant food which brought about similar results.

[1] Ohio Agricultural Experiment Station Bulletin 157, "Winter-Killing of Peach Trees," p. 132.

The unusually deep, hard freezing of the earth's crust was due, directly, to the continued, steady cold, but was intensified, in many instances, by a lack of humus or vegetable matter in the soil, which constitutes nature's insulation of the surface of the earth from cold and heat.

Providing that the orchards had been kept free from fungous disease and the San Jose scale by timely and thorough spraying, no injury of trees was found where stable or barnyard manure had been used upon the ground within the last year or two previous to the winter of 1903–4; rarely was an injured tree found standing in sod; no injury was done where the surface of the soil beneath the trees had been covered with even a very slight mulch; little injury was done where the trees stood in fairly well-drained soil containing a moderate amount of fertility and humus; no injury was found where the trees were under the grass-mulch method of culture . . .; no injury was observed in any case where the stems of the trees had been slightly banked or mounded with a few shovelfuls or forkfuls of soil, peat, or manure.

Very few trees which, within the past few years, had been affected with leaf-curl or infested with San Jose scale or borers remained alive or uninjured; and very few trees existing upon infertile or exhausted soil, depleted of humus, escaped uninjured.

The usefulness of a cover crop in preventing the washing of the soil during the dormant period of the trees is frequently well demonstrated. Moreover, in some regions where the winters are rather severe and there is a very limited snowfall, a cover crop prevents the snow from blowing away, thus affording additional protection against the extreme freezing of the roots.

Another practice which is entirely regional, but which may be of considerable advantage at times, is the shading of the trunks of the trees with board protectors, lath screens, or in some other equally effective manner. This method is of use particularly in regions in which long periods of extremely hot weather usually occur and where the trees are not well shaded on the south and southwest sides. Shading in the manner suggested sometimes affords a measure of protection against the form of winter injury commonly called "sun scald." This is generally caused by too rapid thawing after the trunks have been frozen very hard.

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PEACH VARIETIES
AND THEIR CLASSIFICATION

H. P. GOULD

Pomologist, Office of Horticultural and Pomological Investigations

FARMERS' BULLETIN 918

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C. Issued December 30, 1914, as No. 633; revised, January, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

IN SELECTING fruit varieties for planting one should take into account (1) their adaptability to the conditions in the locality where they are to be planted, (2) their suitability or value for the purpose for which they are to be grown, (3) their season of ripening, and in many cases the order of their ripening with reference to other sorts grown in the same orchard and in other localities.

These features are presented in this bulletin with a view to impressing their importance upon the prospective peach grower who is without previous experience. In the past many orchards have been planted and well cared for until they reached bearing age only to prove after bearing began that they could not be profitable because the varieties planted were not wisely selected.

Lists of peach varieties that are being grown in many different regions throughout the country, with their approximate dates of ripening, make up the body of the bulletin.

Brief reference is made also to the classification of peaches into different races and its significance from the standpoint of their adaptability to different regions.

Cultural practices in the growing of peaches are presented in considerable detail in Farmers' Bulletin 917, which can be secured free of cost on request to the Department of Agriculture.

PEACH VARIETIES AND THEIR CLASSIFICATION.

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VARIETIES OF PEACHES.

ONE of the great problems which peach growers have to consider is involved in the question, which is asked with great frequency, "What varieties shall I plant?" Success or failure, financially, is often determined by the way in which the question is answered. It has to be answered by some one in the development of every orchard. There is usually a chance for the exercise of individual choice within certain limits and the selection of favorite varieties, if there are any. The environment must be considered in the relation of its many factors to the behavior of the varieties, the market conditions that must be met, and transportation facilities.

In many cases, the sequence of ripening is of very great importance and presents one of the most difficult problems to adjust satisfactorily. If a grower whose entire enterprise is the production of peaches wishes to ship fruit throughout the longest possible period, it is essential that his varieties be so selected that they will give him a continuous supply of fruit. Otherwise, there will be periods when his crew will have to be idle on account of breaks in the sequence of ripening; or it may be that at some periods he will have more varieties ripening at the same time than he can handle with the crew which is adequate for the greater portion of the crop. Either extreme presents a serious economic condition in the management of the orchard. To handle the crop satisfactorily and economically, a continuous and uniform supply of fruit is essential.

While the matter of the adaptability of varieties to different conditions calls for much consideration, it is usually a factor that is less

acute than it is with many other fruits. In other words, there are doubtless a good many more varieties of peaches that will develop to a good degree of perfection under a wider range of conditions than is true of many of our other kinds of fruits. But the selection of varieties for growing in different sections that will ripen at a time when the markets are not overstocked is the real problem in this connection. Some districts owe their prominence and importance as peach-growing centers largely to the fact that some of the best market varieties ripen in those districts at times when they usually bring exceptionally large prices, because at those times relatively little fruit is being marketed from other districts.

In the further extension of the peach industry, the selecting of locations with reference to this factor is likely to contribute more to the financial success of the enterprise than the mere choosing of varieties that do well, but without regard to the time when they ripen in comparison with the peach season of other districts.

Thus, a peach grower in New Jersey may know that the Greensboro peach does well under his conditions, but that he can not market it to advantage when there is a good crop of Elberta peaches in Georgia, though it is profitable in seasons of light crops in Georgia. Similarly the Salway peach was formerly a profitable variety to grow in some parts of California, but in certain sections of that State it can not now compete to advantage with the Elberta peach from Colorado. Accordingly, the Salway peach is not found in many of the younger orchards in certain districts of California in which it was formerly a variety of considerable prominence.

From the foregoing statements the difficulty incident to the making of suggestions for the guidance of prospective peach planters in selecting varieties becomes apparent. The prospective peach planter can probably find a better guide as to varieties in the results obtained by experienced growers than by using any other source of information.

VARIETIES GROWN IN THE UNITED STATES.

For the purpose of assembling information concerning the distribution of different varieties in different regions, approximate ripening periods, etc., a large number of growers in many representative districts throughout the country were requested to advise the Department of Agriculture as to the varieties of peaches that had proved to be the most desirable to grow either for commercial purposes or for home use under their respective conditions; also to give as nearly as possible the average date when the ripening season begins of each variety which they might name. A large number of responses were made to this request, and the information thus supplied is compiled below.

The data are arranged alphabetically by States, and under each State the varieties are grouped by counties. The general location of

each county or group of counties within the different States is also indicated. The varieties are placed in each list approximately in the order of ripening.

In making use of these data the reader must observe certain cautions to avoid being misled. Attention is directed to the following items:

(1) The variety lists are only suggestive as to desirable sorts to plant in the different sections.

(2) The sequence of ripening as indicated by the order of arrangement of the varieties in the different lists is only approximate.

(3) The dates of ripening as given for the different varieties are only approximate. In some instances, where conditions vary widely within the counties grouped together, the ripening dates of a variety will be found to differ greatly in different orchards.

(4) The mention of a county in the following lists must not be construed as evidence that the conditions therein are necessarily favorable to the development of a profitable peach industry. The data regarding variety distribution and ripening may be useful, nevertheless.

(5) On the other hand, there are many localities in counties not named in any of the lists which are admirably adapted to peach growing. No attempt has been made to furnish a complete inventory of the counties in which peach culture is successful; therefore the omission of the names of counties in this connection is absolutely without significance so far as their adaptability to peach growing is concerned.

If the reader observes these cautions and regards the varietal data as a means of helping him to reach wise conclusions and not as fully considered and definitely stated facts, it is believed that this assemblage of variety lists will be of some value.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties.

State and section.	Varieties.	Begin to ripen.
ALABAMA.		
Mobile, Escambia, and Washington Counties (southwest).	Arp	May 25.
	Greensboro	May 28.
	Carman	June 8.
	Rivers	June 10.
	Hiley	June 15.
	Slappey	Do.
	Belle	June 20.
	Elberta	July 1.
Cleburne and Lee Counties (east central).	Carman	June 15.
	Hiley	June 25.
	Mamie Ross	July 1.
	Belle	July 10.
	Elberta	July 15.
Dekalb County (northeast).	Carman	June 25.
	Waddell	July 10.
	Mountain Rose	July 20.
	Belle	Do.
	Ray	Do.
	Elberta	July 25.
ARKANSAS.		
Benton, Boone, and Washington Counties (northwest).	Alexander	June 1.
	Sneed	Do.
	Greensboro	June —.
	Triumph	Do.
	Champion	July 10.
	Family Favorite	July 15–25.
	Belle	July 20.
	Chinese Cling	Do.
	Elberta [1]	July 25.
	Heath	Sept. 10–25.
Pike County (southwest).	Elberta [2]	July 10.
ARIZONA.		
Graham County (southeast).	Elberta [3]	
	Indian Cling	
	Perkins	
	Salway	
	Stinson	

[1] Elberta is considered the only variety of commercial importance and is estimated to comprise 95 per cent of all the peaches planted in some localities in this section.

[2] Carman, Mamie Ross, and other early sorts are grown to a very limited extent; Salway and other late varieties are produced in small quantities and develop to a good degree of perfection, but the prevailing prices received for them are unsatisfactory.

[3] This variety is reported to be the most reliable as to crop.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties—Continued.

State and section.	Varieties.	Begin to ripen.
CALIFORNIA.		
San Diego County (south).	Japan Dwarf	June 20–July 1.
	Early Crawford	July 4–15.
	Strawberry	July 15–Aug. 1.
	Late Crawford	Aug. 20–Sept. 10.
	Yellow Cling	Sept. 20–Oct. 10.
	Salway	Oct. 20–Nov. 15.
Sonoma and Contra Costa Counties[1] (central coast).	Alexander	
	Triumph	
	Early Hale	
	Tuskena[2]	
	Early Crawford	
	Foster	
	Elberta	
	Muir	
	McKevitt	
	Heath	
Sutter and Yuba Counties[3] (central valley).	Tuskena[2]	July 15–Aug. 5.
	Hauss	Aug. 1–15.
	Johnson	Do.
	Walton	Do.
	Albright Cling	Aug. 10–20.
	Runyon	Aug. 15–30.
	Nichols	Do.
	Sellers	Do.
	Muir[4]	Do.
	Lovell[4]	Sept. 1–15.
	Phillips	Do.
	Levy	Sept. 10–25.
Solano County (central valley).[5]	Sneed	May 28.
	Alexander[6]	May 29–June 18.
	Garland	June 5.
	Triumph[6]	June 11–30.
	St. John[6]	June 13–July 9.
	Dewey	June 16–25.
	Early Hale[6]	June 22–July 5.
	Strawberry	June 30–July 12.
	Early Crawford[6]	June 30–July 22.
	Foster[6]	July 4–24.
	Decker	July 4–18.
	Orange Cling	July 14–29.
	Mary (*Mary's Choice*).	July 15–24.
	Susquehanna[6]	July 23–Aug. 4.
	Yellow Free	July 25.
	Elberta[6]	July 24–Aug. 8.
	Late Crawford	July 30.
	Lovell	Sept. 2.
	Picquet	Sept. 5.
	Salway[6]	Sept. 11–Oct. 17.
Butte County (northern valley).	Muir[7]	Aug. 10–20.
	Lovell[7]	Aug. 20–30.
CALIFORNIA—continued.		
Amador, Eldorado, and Placer Counties (central foothills).	Alexander	June 25–Aug. 5.
	Triumph	July 5–Aug. 5.
	Early Hale	July 8–Aug. 8.
	Imperial	July 11–21.
	Early Crawford	July 30–Aug. 20.
	Strawberry	July 30–Sept. 18.
	Orange	July 30–Oct. 31.
	Late Crawford	Aug. 2–Sept. 3.
	Strawberry Cling	Aug. 4–Oct. 13.
	Yellow Cling	Aug. 4–Sept. 13.
	Elberta	Aug. 4–Sept. 4.
	Yellow Free	Aug. 8–Sept. 16.
	Muir	Aug. 15.
	Susquehanna	Do.
	Lemon Cling	Aug. 20.
	Picquet	Aug. 20–Oct. 21.
	McDevitt	Aug. 24–Sept. 4.
	Salway	Sept. 3–Oct. 4.
	Levy	Sept. 3–Oct. 10.
	Phillips	Sept. 4–20.
	Norris	Sept. 8–20.
COLORADO.		
Mesa County (west, Grand Valley).	Carman	
	Early Crawford	
	Foster	
	Elberta[8]	Sept. 1.
	Salway	
Delta County (west).[9]	Sneed	
	Triumph	
	Greensboro	
	Carman	Aug. 20
	Early Crawford	
	Elberta[8]	Sept. 5–15.
	Muir[10]	
Montrose County (west).	Early Hale	
	Early Crawford	
	Elberta[11]	Sept. 5–10.
	Lovell[12]	
Montezuma County (southwest)[13]	Triumph	
	Bishop	Aug. 15.
	Mountain Rose	Aug. 18.
	Champion	Aug. 20.
	Family Favorite	Aug. 25.
	St. John	Sept. 1.
	Foster	Sept. 5.
	Oldmixon Free	Sept. 10.
	Elberta	Sept. 10–15.
	Washington	Do.
Larimer County (north central).	Greensboro	July 20.
	Belle	Sept. 5.
	Elberta	Sept. 20.

[1] Peach interests are less important in these counties than in many other parts of the State.

[2] This is generally known in California by its synonym *Tuscan*.

[3] Except as stated in the next footnote, this list comprises the leading clingstone varieties grown in California that are largely used for canning.

[4] These are freestone varieties. While they are canned to a considerable extent, they are the leading varieties grown in California for drying.

[5] The peaches grown in this section are largely shipped in the fresh state. The wide range in dates of ripening is due to the difference in the location of the orchards. The dates show when the first shipment was made of the different varieties from different orchards in the vicinity of Vacaville in the season of 1913.

[6] The varieties thus designated are the principal sorts grown in this locality. The other varieties are grown only in small quantities.

[7] These varieties are grown here almost exclusively for drying.

[8] This variety excels commercially. The other varieties are grown but little.

[9] The elevation is about 6,000 feet.

[10] This is grown to a very limited extent for drying.

[11] This variety excels commercially.

[12] This is grown to a limited extent for drying and canning.

[13] The elevation is 6,400 feet.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties—Continued.

State and section.	Varieties.	Begin to ripen.
CONNECTICUT.		
Middlesex and New Haven Counties (south).	Mayflower	July 25–Aug. 1.
	Greensboro	July 28–Aug. 10.
	Waddell	Aug. 8–15.
	Carman	Aug. 10–18.
	Hiley	Aug. 20–25.
	Mountain Rose	Aug. 25–Sept. 5.
	Champion	Aug. 25–Sept. 8.
	Belle	Sept. 1–10.
	Early Crawford	Sept. 1.
	Elberta	Sept. 5–15.
	Stump	Sept. 8.
	Late Crawford	Sept. 15.
	Chairs	Sept. 20.
	Fox	Sept. 20–25.
	Iron Mountain	Oct. 1–10.
	Stevens	Oct. 5–10.
	Salway	Oct. 10.
	Bilyeu	Oct. 15–20.
Tolland and Litchfield Counties (north central and northwest).	Greensboro	Aug. 1.
	Waddell	Aug. 10.
	Carman	Aug. 20.
	Mountain Rose	Do.
	Champion	Aug. 25.
	Belle	Aug. 30.
	Oldmixon Free	Sept. 1–10.
	Elberta	Sept. 5.
	Stump	Sept. 10.
	Crosby	Do.
	Fox	Sept. 25.
	Stevens	Sept. 28.
	Smock	Oct. 1.
DELAWARE.		
Sussex County (south).	Greensboro	July 10.
	Carman	July 25.
	Champion	Aug. 1.
	Oldmixon Free	Aug. 10.
	Belle	Do.
	Elberta	Aug. 15.
	Late Crawford	Aug. 20.
	Stevens	Aug. 30.
	Smock	Sept. 5.
Kent County (central).	Champion	Aug. 10.
	Belle	Aug. 15.
	Reeves	Aug. 20.
	Elberta	Aug. 25.
FLORIDA.		
Volusia County (east central).	Jewell	May 10–20.
	Suber	Do.
	Angel	May 25–June 1.
	Hall Yellow	Do.
	Waldo	Do.
Alachua and Putnam Counties (north).	Jewell	May 25–June 5.
	Waldo	June 1–15.
	Colon	June 15.
	Angel	June 20–25.
	Taber	July 1.
GEORGIA.		
Macon, Houston, and Crawford Counties (central).	Mayflower	May 20–June 5.
	Greensboro	May 25–June 10.
	Carman	June 5–20.
	Waddell	June 10–15.
	Hiley	June 15–25.
	Belle	June 20–July 2.
	Elberta	July 1–10.
Hancock County (east central).	Carman	June 18–20.
	Hiley	June 26–July 8.
	Thurber	July 8–15.
	Belle	July 8–18.
	Elberta	July 12–22.
GEORGIA—con.		
Habersham County (northeast).	Belle	July 10.
	Elberta	July 20.
	Fox	Aug. 20.
	Heath	Sept. 25.
IDAHO.		
Canyon County (southwest).	Carman	Aug. 1–5.
	Minnie (*Alton*)	Aug. 5–10.
	Elberta	Aug. 28–Sept. 12.
	Lovell	Sept. 10–20.
	Salway	Sept. 15–Oct. 15.
Kootenai County (north).	Mayflower	July 15.
	Alexander	July 15–25.
	Early Hale	July 20.
	Triumph	July 25.
	Carman	Aug. 1.
	Minnie (*Alton*)	Aug. 10.
	Champion	Aug. 20.
	Elberta	Aug. 25.
ILLINOIS.		
Jackson County (south).	Mountain Rose	July 30.
	Washington	Aug. 10.
	Ede	Do
	Elberta	Do.
	Oldmixon Cling	Aug. 13.
	Oldmixon Free	Aug. 20.
	Stump	Do.
	Schumaker	Do.
	Stevens	Sept. 1.
	Ward	Do.
	Smock	Sept. 10.
	Heath	Sept. 15.
Cumberland County (east central).	Carman	Aug. 1–5.
	Waddell	Aug. 2–10.
	Minnie (*Alton*)	Aug. 15–20.
	Champion	Aug. 20–30.
	Elberta	Aug. 25–30.
McDonough County (west central).	Sneed	July 1–15.
	Mamie Ross	Aug. 15–20.
	Niagara	Do.
	Elberta	Sept. 1–15.
	Crosby	Sept. 5–15.
INDIANA.		
Jennings County (southeast).	Champion	Aug. 1.
	Mountain Rose	Aug. 15.
	Early Crawford	Aug. 20.
	Oldmixon Free	Do.
	Elberta	Aug. 25–30.
	Smock	Sept. 10.
	Heath	Oct. 1.
Rush and Hamilton Counties (central).	Alexander	July 10.
	Greensboro	July 15–20.
	Carman	
	Triumph	July 25.
	Champion	Aug. 15.
	Early Crawford	Aug. 25.
	Foster	Do.
	Belle	Sept. 1.
	Kalamazoo	Sept. 10.
	Oldmixon Free	Do.
	Elberta	Sept. 15.
	Arctic	Sept. 20.
	Late Crawford	Sept. 25.
	Stump	Sept.
	Hannah	Sept. 25.
	Lemon Cling	Do.
	Wonderful	Oct. 1.
	Heath	Oct. 5.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties—Continued.

State and section.	Varieties.	Begin to ripen.
IOWA.		
Henry and Wayne Counties (southeast).	Alexander	July 10–25.
	Triumph	July 25–Aug. 5.
	Forbes	Aug. 1.
	Champion	Aug. 10–31.
	Early Crawford	Aug. 25–Sept. 5.
	Bokhara	Aug. 28–Sept. 5.
	Crosby	Sept. 1.
	Elberta	Sept. 4–10.
	Late Crawford	Sept. 5–20.
	Heath	Sept. 15–Oct. 10.
KANSAS.		
Barber County (south central).	Sneed	June 15.
	Triumph	July 1.
	Greensboro	July 10.
	Carman	July 15.
	Champion	July 20.
	Early Crawford	Aug. 1.
	Foster	Do.
	Chinese Cling	Aug. 15.
	Elberta	Do.
	Late Crawford	Sept. 1.
	Stevens	Sept. 15.
	Globe	Sept. 25.
	Wonderful	Oct. 1.
	Mammoth Heath.	Oct. 15.
	Levy (*Henrietta*).	Oct. 20.
Douglas, Franklin, Johnson, and Morris Counties (east central).	Sneed	June 15.
	Arp	
	Alexander	June 25.
	Triumph	June 25–30.
	Dewey	July 10–15.
	Early Crawford	July 15.
	Mountain Rose	Aug. 1.
	Champion	Aug. 10–30.
	Belle	Aug. 15–Sept. 15.
	Oldmixon Free	Do.
	Ede	
	Elberta	Aug. 20–Sept. 15.
	Fitzgerald	Aug. 25–Sept. 15.
	Late Crawford	Sept. 1–20.
	Chairs	Sept. 5–15.
	Mathews	Sept. 12–25.
	Smock	Sept. 15.
	Gold Drop	Sept. 25.
	Beers Smock	Sept. 28.
	Wonderful	Oct. 1–10.
	Salway	Oct. 5–10.
Atchison and Jackson Counties (northeast).	Sneed	
	Greensboro	
	Carman	July 20–25.
	Bishop	July 20–30.
	Champion	Aug. 1–20.
	Elberta	Aug. 20–Sept. 10.
	Crosby	Aug. 20–25.
	Heath	Oct. 10.
KENTUCKY.		
Warren County (south central).	Carman	July 1.
	Champion	July 25.
	Early Crawford	Aug. 1.
	Elberta	Aug. 10.
Hardin and Bullitt Counties (north central).	Early Crawford	July 20–Aug. 1.
	Mountain Rose	July 20–Aug. 4.
	Oldmixon Free	Aug. 8–15.
	Elberta	Aug. 10–15.
	Late Crawford	Aug. 15.
	Admirable	Aug. 20–Sept. 1.
	Oldmixon Cling	Aug. 25–Sept. 5.
	Smock	Sept. 10.
	Levy (*Henrietta.*)	Sept. 15.
	Heath	Sept. 15–25.
	Salway	Oct. 1.
LOUISIANA.		
Bienville Parish (northwest).	Early Wheeler	
	Greensboro	
	Carman	
	Belle	
	Elberta	
MARYLAND.		
Caroline County (east).	Carman	July 20–30.
	Belle	July 25–Aug. 5.
	Reeves	Do.
	Mary (*Mary's Choice*).	Do.
	Elberta	July 30–Aug. 10.
	Bequette Free	Aug. 5–15.
	Bequette Cling	Do.
	Oldmixon Free	Aug. 10.
	Chairs	Aug. 15–25.
	Late Crawford	Do.
	Heath	Aug. 25–30.
Washington County (west).	Troth	
	Carman	
	Champion	Aug. 1–15.
	Early Crawford	Aug. 5–15.
	Chinese Cling	
	St. John	Aug. 8.
	Mountain Rose	Aug. 10
	Oldmixon Free	
	Reeves	Aug. 10–25.
	Moore	Do.
	Elberta	Do.
	Late Crawford	Aug. 25–Sept. 1.
	Stump	
	Fox	
	Chairs	Sept. 1–7.
	McCollister	Sept. 5–20.
	Geary	Sept. 10–25.
	Wonderful	Sept. 15.
	Salway	Sept. 20–25.
	Levy	Sept. 20.
	Wilkins	Sept. 20–30.
	Heath	Oct. 1–5.
	Bilyeu	Oct. 15.
MASSACHUSETTS.		
Hampden County (southwest).	Greensboro	Aug. 5.
	Carman	Aug. 15–20.
	Hiley	Aug. 20–25.
	Champion	Sept. 1–5.
	Belle	Sept. 5–10.
	Crosby	Sept. 20–25.
	Salway	Oct. 1–5.
Middlesex County (east central).	Greensboro	Aug. 15–18.
	Carman	Aug. 20.
	Mountain Rose	Sept. 1.
	Early Crawford	Sept. 1–12.
	Belle	Sept. 10–15.
	Elberta	Sept. 10–20.
	Crosby	
Essex County (northeast).	Victor	July 25.
	Sneed [1]	Do.
	Triumph [1]	
	Greensboro	Aug. 5.
	Carman	Aug. 18
	Waddell	Aug. 15.
	Champion	Aug. 25.
	Early York	Do.
	Mountain Rose	Aug. 25–30.
	Hiley	Aug. 28.
	Belle	Sept. 5–10.
	Fitzgerald	Sept. 8.
	Oldmixon Free	Sept. 10–12.
	Kalamazoo	Sept. 15–20.
	Elberta	Do.
	Crosby [1]	Sept. 20.
	Stump	Sept. 20–25.
	Chairs	Sept. 25–30.
	Stevens	Oct. 1.

[1] These varieties are suggested for home use rather than for market.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties—Continued.

State and section.	Varieties.	Begin to ripen.
MICHIGAN.		
Berrien, Van Buren, and Allegan Counties (southwest).	Dewey	Aug. 15.
	Lewis	Aug. 15–20.
	St. John	Aug. 25–30.
	Champion	Aug. 28.
	Engle	Aug. 28–Sept. 10.
	Kalamazoo	Sept. 1–10.
	New Prolific	Sept. 1–8.
	Belle	Sept. 1.
	Fitzgerald	Sept. 1–8
	Elberta	Sept. 5–15.
	Gold Drop	Sept. 12–25.
	Lemon Free	Sept. 15–Oct. 1.
	Beers Smock	Sept. 15–25.
	Smock	Sept. 20–25.
	Salway	Sept. 20–Oct. 5.
	Ailesworth	Sept. 25.
Eaton County (south central).	Lewis	Aug. 15.
	Engle	Sept. 5.
	Kalamazoo	Sept. 10.
	Elberta	Sept. 15.
	Chili	Sept. 20.
	Gold Drop[1]	Sept. 25.
Grand Traverse County (northwest, lower peninsula).	Alexander	Aug. 1.
	Rivers	Aug. 5.
	Triumph	Aug. 10.
	Dewey	Do.
	Fitzgerald	Sept. 10.
	Early Crawford	Sept. 15.
	Crosby	Do.
	New Prolific	Sept. 20.
	Elberta	Sept. 18.
	Chili	Oct. 1.
MISSOURI.		
Oregon County [2] (south central).	Elberta [3]	July 28–Aug. 8.
Howell County [4] (south central).	Elberta [3]	Aug. 10–15.
Wright County [5] (south central).	Carman	Not reported.
	Champion	
	Elberta	
	Salway	
Cole County (central).	Greensboro	June 25–July 10.
	Carman	July 25–30.
	Mountain Rose	Aug. 1–15.
	Elberta	Aug. 25–Sept. 10.
	Heath	Sept. 25–Oct. 10.
NEBRASKA.		
Varieties most commonly found in the State.	Alexander	Not reported.
	Triumph	
	Rivers	
	Early Hale	
	Champion	
	Crosby	
	Chili	
	Russell	
	Wright	
	Heath	
	Salway	

State and section.	Varieties.	Begin to ripen.
NEW HAMPSHIRE.		
Hillsboro and Merrimack Counties (south central).	Triumph	Aug. 15.
	Carman	Aug. 20–Sept. 1.
	Waddell	Aug. 25.
	Mountain Rose	Sept. 1–15.
	Champion	Do.
	Early Crawford	Sept. 5–10.
	Elberta	Sept. 10–20.
	Crosby	Sept. 15–20.
NEW JERSEY.		
Burlington and Cumberland Counties (south and west central).	Greensboro	July 15–Aug. 1.
	Waddell	July 25–Aug. 10.
	Carman	Aug. 1–10.
	Mountain Rose	Aug. 5–10.
	Hiley	Do.
	Champion	Aug. 10–15.
	Oldmixon Free	Aug. 15–25.
	Belle	Aug. 15–20.
	Elberta	Aug. 20–25.
	Fox	Aug. 25–Sept. 10.
	Stump	Sept. 1.
	Late Crawford	Sept. 1–5.
	Iron Mountain	Sept. 15–20.
Middlesex, Monmouth, and Union Counties (east central).	Carman	Aug. 10–20.
	Ray	Aug. 10–Sept. 1.
	Belle	Aug. 15–Sept. 1.
	Elberta	Aug. 25–Sept. 10.
	Ellison	Sept. 1–20.
	Willett	Do.
	Stump	Sept. 7.
	Stevens	Sept. 15.
	Keyport	Sept. 20.
NEW MEXICO.		
Chaves and Eddy Counties (southeast, Pecos Valley).	Victor	
	Alexander	
	Dewey	
	Triumph	June 20–25.
	Greensboro	
	Carman [6]	July 10.
	Ray	July 4.
	Texas (*Texas King*)	
	Mamie Ross	
	Family Favorite	
	Superb [6]	July 25.
	Champion [6]	July 25–Aug. 1.
	Elberta [6]	Aug. 1–5.
	Late Crawford	
	Crosby	
	Beckett	
	Lee	
	Salway	Sept. 5.
	Levy	
	Krummel	Oct. 1.
	Belle October	
Dona Ana County (south central).	Alexander	June 20–30.
	Rivers	June 20.
	Triumph	
	Carman	
	Texas (*Texas King*).	July 15–20.
	Mamie Ross	
	Early Crawford	
	Belle	

[1] This is one of the most hardy varieties.
[2] The elevation is about 960 feet.
[3] Other varieties are grown in these counties, but the Elberta is the only one of real commercial importance.
[4] The elevation is about 1,240 feet.
[5] The elevation is about 1,680 feet.
[6] Considered by some to be the most desirable varieties for commercial purposes.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties—Continued.

State and section	Varieties.	Begin to ripen.
NEW MEXICO—continued.		
Dona Ana County (south central)—Con.	Elberta	Aug. 1.
	Late Crawford	
	Keith	
	Crothers	Aug. 20–25.
	Lemon Cling	
	Salway	Sept. 20–25.
San Juan County (northwest).	Alexander	July 25–Aug. 15.
	Triumph	July 15–Aug. 15.
	Carman	Aug. 15–Sept. 1.
	Champion [1]	Aug. 25–Sept. 1.
	Elberta [1]	Sept. 1–10.
	Krummel	Oct. 1–10.
	Salway	Oct. 5–10.
NEW YORK.[2]		
Nassau and Suffolk Counties (southeast, Long Island)	Carman	Not reported.
	Champion	
	Belle	
	Elberta	
	Stump	
	Oldmixon Free	
	Smock	
	Iron Mountain	
	Salway	
Westchester, Dutchess, and Ulster Counties (southeast, Hudson River Valley).	Greensboro	July 25.
	Champion	Aug. 15–20.
	Niagara	Aug. 25.
	Elberta	Sept. 1–10.
	Fitzgerald [3]	
	Crosby	Sept. 1.
	Late Crawford	Sept. 1–10.
	Stevens	Sept. 25.
Tompkins and Yates Counties (central).	Greensboro	Aug. 1–20.
	Carman	Do.
	Champion	Aug. 20.
	St. John	Aug. 25–30.
	Early Crawford	Sept. 1.
	Elberta	Sept. 1–15.
	Crosby	Sept. 5–10.
	Chili	Do.
	Morris	Sept. 10.
	Stevens	Sept. 15–25.
	Stump	Sept. 15.
	Late Crawford	Sept. 20.
	Smock	Sept. 20–30.
	Fox	Sept. 25.
	Iron Mountain	Sept. 25–30.
	Salway	Oct. 1–10.
Oswego, Wayne, and Niagara Counties (west).	Triumph	Aug. 15.
	Greensboro	Aug. 20.
	Rivers	Do.
	St. John	Do.
	Early Crawford	Sept. 1–10.
	Mountain Rose	Sept. 5.
	Fitzgerald	Sept. 5–10.
	Niagara	Sept. 6–20.
	Foster	Sept. 8–15.
	Champion	Sept. 10.
	Wheatland	Sept. 10–15.
	Elberta	Sept. 10–25.
	Late Crawford	Sept. 20–25.
	Lamont	Sept. 20–30.
	Chili	Oct. 1.
NORTH CAROLINA.		
Moore County (central).	Mayflower	June 1.
	Alexander	June 10.
	Greensboro	June 20.
	Carman	July 5.
	Belle	July 15.
	Elberta	July 20.
OHIO.		
Lawrence, Clermont, and Ross Counties (south).	Greensboro	July 1.
	Rivers	July 15.
	Carman	July 20.
	Champion	Aug. 1–15.
	Mountain Rose	Aug. 1–10.
	New Prolific	Aug. 1.
	Oldmixon Free	Aug. 5–20.
	Reeves	Aug. 8–25.
	Elberta	Aug. 10–Sept. 1.
	Late Crawford	Aug. 15.
	Stump	Aug. 15–Sept. 1.
	Chairs	Sept. 5.
	Smock	Sept. 10–20.
	Wonderful	Sept. 15.
	Beers Smock	Do.
	Salway	Sept. 20–25.
	Heath	Oct. 1.
Summit, Lucas, and Lake Counties (north).	Carman	Aug. 5–20.
	St. John	
	Champion	Aug. 10–25.
	New Prolific	
	Kalamazoo	
	Belle	
	Elberta	Aug. 25–Sept. 25.
	Gold Drop	
	Stump	Sept. 1.
	Crosby	Sept. 1–15.
	Lemon Free	Sept. 10–20.
	Smock	Sept. 15–25.
	Salway	Sept. 20–Oct. 1.
OKLAHOMA.		
Cherokee, Logan, and Canadian Counties (central).	Mayflower	June 1.
	Sneed	Do.
	Early Wheeler	June 1–10.
	Mamie Ross	June 10.
	Hiley	July 10–20.
	Champion	July 20.
	Elberta	Aug. 1–20.
	Krummel	Sept. 15.
	Salway	Oct. 1.
OREGON.		
Jackson County (southwest).	Alexander	July 15.
	Early Hale	Aug. 1.
	Early Crawford	Aug. 15.
	Elberta	
	Muir	Sept. 15.
	Late Crawford	
	Salway	Oct. 15.
Umatilla County (northeast).	Arp	July 15.
	Early Crawford	Aug. 1.
	Elberta	Aug. 25–30.
	Salway	Sept. 15–30.

[1] These are considered the best varieties for commercial purposes.

[2] The following varieties named in the approximate order in which they are reported to ripen are given by the New York Agricultural Experiment Station (Circular 15, revised) as the "most worthy of consideration": Rivers, Greensboro, Eureka, Carman, Minnie (*Alton*), St. John, Waddell, Pearson, Foster, Stevens, Champion, Fitzgerald, Niagara, Belle, Early Crawford, Elberta, Oldmixon Free, Ede, Crosby, Late Crawford, Kalamazoo, Chili, Lamont, Smock, Salway.

From the same circular the following information regarding the hardiness of varieties is taken: "The five varieties of peaches most hardy in wood are Crosby, Chili, Stevens, Gold Drop, and Elberta. The Crawfords are considered most tender in wood. The five varieties of peaches most hardy in bud are Crosby, Chili, Triumph, Gold Drop, and Stevens. The five most tender in bud are the Early Crawford, Late Crawford, Chairs, Reeves, and Elberta."

[3] This variety is recommended for home use.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties—Continued.

State and section.	Varieties.	Begin to ripen.
PENNSYLVANIA.		
Bucks County (southeast).	Mountain Rose	July 15.
	Champion	Aug. 1.
	Early Crawford	Sept. 1.
	Elberta	Sept. 15.
	Late Crawford	Sept. 20.
	Chairs	
	Stevens	Sept. 25.
	Beers Smock	Oct. 1.
Berks County (southeast).	Greensboro	July 15–20.
	Carman	Aug. 4–10.
	Champion	Aug. 21–28.
	Belle	
	Elberta	Aug. 15–Sept. 5.
	Stevens	Aug. 25–Sept. 10.
Clinton and Northumberland Counties (center).	Sneed	July 10–15.
	Carman	Aug. 1–10.
	Slappey	Aug. 15–20.
	Mountain Rose	Do.
	Belle	Aug. 25–30.
	Reeves	Do.
	Oldmixon Free	Sept. 1–15.
	Elberta	Do.
	Late Crawford	Sept. 10–15.
	Crosby	Do.
	Stump	Sept. 15–20.
	Fox	Do.
	Chairs	Sept. 20–25.
	Smock	Sept. 25–30.
	Salway	Sept. 30–Oct. 5.
	Bilyeu	Oct. 1–7.
Wayne County (northeast).	Sneed	July 18.
	Canada	July 31.
	Greensboro [1]	Aug. 2.
	Carman [1]	Aug. 23.
	Champion [1]	Aug. 28.
	Fitzgerald	Sept. 4.
	Hiley	Sept. 8.
	Belle [1]	Sept. 12.
	Ede	Do.
	Ray	Do.
	Reeves	Do.
	Elberta [1]	Sept. 20.
	Crosby	Do.
	Late Crawford	Sept. 25.
	Iron Mountain	Do.
	Salway	Sept. 30.
RHODE ISLAND.		
Newport County (southeast).	Victor	Aug. 10.
	Carman	Aug. 25.
	Hiley	Sept. 1.
	Champion	Sept. 5.
	Ray	Do.
	Kalamazoo	Sept. 10.
	Morris	Sept. 20.
SOUTH CAROLINA.		
Aiken and Lexington Counties (central).	Sneed	May 10–30.
	Alexander	May 20.
	Greensboro	June 10–20.
	St. John	July 1–15.
	Elberta	July 1–25.
SOUTH CAROLINA—con.		
Pickens County (west).	Sneed	May 10–28.
	Greensboro	June 1–15.
	Carman	June 18–30.
	Mamie Ross	
	Connet	June 20–July 2.
	Belle	
	Elberta	July 10–25.
South Carolina (entire State).[2]	Mayflower	May 25–June 5.
	Greensboro	June 1–10.
	Carman	June 10–20.
	Mamie Ross	June 20–July 4.
	Belle	July 6–15.
	Elberta	July 15–Aug. 1.
	Crothers	Aug. 5–18.
	Oldmixon Free	Sept. 8–20.
	Stinson	Oct. 10–20.
TENNESSEE.		
Rhea County (southeast).	Carman	July 5–10.
	Belle	July 15–20.
	Early Crawford	
	Reeves	
	Elberta	July 25.
	Late Crawford	
	Mathews	
	Smock	
	Bilyeu	
Bedford County (central).	Carman	Not reported.
	Champion	
	Belle	
	Elberta	
	Crothers	
Blount County (east central).	Sneed	May 25–June 5.
	Greensboro	June 10–25.
	Carman	June 25–July 10.
	Belle	July 15–30.
	Elberta	July 20–Aug. 5.
	Thurber	Do.
Claiborne County (northeast).	Alexander	June 20.
	St. John	July 4.
	Mountain Rose	July 15.
	Belle	
	Elberta	Aug. 5.
TEXAS.		
Bexar and Victoria Counties (southeast).	Clara	June 1.
	Early China	Do.
	Honey	June 5.
	Triumph	June 14.
	Imperial	July 1.
	Pallas	Do.
	Gardina	Do.
	Rupley	July 15.
	Alice	Do.
	Cabler	July 20.
	Maggie	Do.
	Onderdonk	Do.
	Lola	July 25.
	Edith	Do.
	Galveston	Aug. 5.
	Guadalupe	Aug. 10.
	Texas	Do.
	Mary	Aug. 25.
	Orman	Sept. 1.

[1] These varieties are the principal commercial sorts.

[2] See South Carolina Agricultural Experiment Station Circular No. 21, entitled "Peach Culture for South Carolina," by C. F. Niven, wherein a list of varieties adapted to the entire State is given.

Lists of peach varieties, showing approximate dates and sequence of ripening in different sections, arranged by States and counties—Continued.

State and section.	Varieties.	Begin to ripen.
TEXAS—con.		
McLennan, Kaufman, and Montague Counties (northeast).	Sneed	May 25.
	Swan	Do.
	Early Wheeler	June 1.
	Arp	June 2.
	Carman	June 10–15.
	Mamie Ross	June 15–25.
	Champion	July 1–10.
	Elberta	July 4–15.
	Chilow	July 15.
	Munson	July 25.
	Weaver	Aug.
	Stinson	Sept.
Limestone[1] County (northeast).	Victor	
	Early Wheeler	
	Swan	
	Carman	
	Mamie Ross	
	Leona	
	Elberta	
	Tena	
	Gilbert	
	Millard	
	Frank	
	Lizzie	
	Barbara	
	Katie	
Deaf Smith and Hale Counties (northwest, Panhandle).	Alexander	June 25–July 1.
	Triumph	July 5–10.
	Mamie Ross	July 5–15.
	Champion	July 20.
	Family Favorite	Do.
	Elberta	July 25.
	Landrum	Aug. 25.
	Buttram	Sept. 15.
	Dalmont	
	Horlacher	
	Krummel	
UTAH.		
Washington County (southwest).	Briggs	July 1.
	Greensboro	July 4.
	Elberta	Aug. 15.
	Muir	Aug. 25.
	Heath	Sept. 20.
Box Elder, Utah, and Weber Counties (central and northern).	Elberta[2]	Sept.
VERMONT.		
Windham County (southeast).	Alexander	
	Rivers	
	Canada	Aug. 15–20.
	Early Crawford	
	Niagara	Sept. 1–15.
	Oldmixon Free	
	Elberta	
	Stump	Sept. 20.
	Crosby	
	Late Crawford	Sept. 25.
VIRGINIA.		
Wythe County (southwest).	Belle	
	Champion	July 25.
	Fitzgerald	Aug. 1.
	Foster	
	Elberta	Aug. 10–15.
VIRGINIA—con.		
Botetourt County (west).	Greensboro	July 1.
	Carman	July 5.
	Champion	July 15.
	Elberta	Aug. 1.
Albemarle County (central).	Oldmixon Free	
	Globe	
	Elberta	Aug. 3–10.
	Late Crawford	Sept. 25–30.
	Heath	Oct. 1–10.
	Albright	Sept. 25–Oct. 10.
	Bilyeu	
Elizabeth City County (east).	Greensboro	Not reported.
	Carman	
	Elberta	
Fairfax and Loudoun Counties (north).	Greensboro	June 20.
	Carman	July 15–25.
	Belle	Aug. 10–20.
	Oldmixon Free	Do.
	Elberta	Aug. 15–25.
	Stump	Sept. 15–20.
	Oldmixon Cling	Sept. 20.
	Salway	Oct. 1–15.
WASHINGTON.		
Benton and Yakima Counties (south central, Yakima Valley).	Alexander	July 10.
	Early Hale	July 15.
	Champion	July 25.
	Early Crawford	Aug. 5.
	Slappey	Aug. 10.
	Elberta	Aug. 15–20.
	Late Crawford	Aug. 20.
Chelan County (central).	Sneed	July 10.
	Alexander	July 15.
	Early Hale	July 15–20.
	Triumph	July 25–Aug. 10.
	Early Crawford	Aug. 10.
	Elberta	Aug. 25.
	Late Crawford	Aug. 25–30.
	Krummel	Oct. 1.
Stevens County (northeast).	Early Crawford	Sept. 8.
	Niagara	Sept. 10.
	Wager	Sept. 15.
	Late Crawford	Sept. 20.
	Elberta	Oct. 1.
WEST VIRGINIA.		
Morgan, Hampshire, and Mineral Counties (northeast).	Carman	July 25–Aug. 5.
	Connet	Aug. 1–10.
	Hiley	Aug. 5–10.
	Champion	Aug. 10–20.
	Belle	Aug. 15–20.
	Oldmixon Free	Aug. 18–25.
	Reeves	Aug. 20–25.
	Elberta	Aug. 20–Sept. 5.
	Fox	Sept. 1–20.
	Walker	Sept. 20–25.
	Stevens	Sept. 20–30.
	McCollister	Do.
	Beers Smock	Do.
	Smock	Sept. 25–30.
	Wonderful	Do.
	Levy	Oct. 1–10.
	Heath	Do.
	Salway	Do.
	Bilyeu	Oct. 10–25.

[1] These varieties have received special attention in this county, where a considerable proportion of them originated. Nearly all of them belong to the "North China" or "Chinese Cling" group. This list of varieties, substantially as it here appears, was originally presented by Mr. J. W. Stubenrauch, of Texas, before a meeting of horticulturists held at Dallas, Tex., and later published in Farm and Ranch (issue of Feb. 28, 1913, p. 9). They are named in about the order in which they ripen, this period for the entire list continuing for 3 to 4 months.

[2] This variety is grown almost to the exclusion of all other sorts.

COMMENTS ON THE FOREGOING LISTS.

As already stated, the foregoing lists are made up in nearly every case of varieties mentioned by growers in response to a request sent them from the Department of Agriculture to name the sorts which were considered the most satisfactory under their respective conditions. They represent practically the entire portion of the country where peaches are grown at all, including many sections in which this fruit is not a commercial product.

Several interesting observations are suggested by these lists. The comparatively small number of varieties which compose them is noticeable. The remarkably wide distribution of a considerable number of varieties, as is shown by the large proportion of the lists in which certain sorts occur, will at once appeal to those who are studying varietal adaptability.

The fact is striking that in response to a request for the names of the most satisfactory varieties, growers all over the country reported, with but few exceptions, only the older and thoroughly tested sorts; and, conversely, the almost entire absence from these lists of recently introduced varieties stands out conspicuously to those who are familiar with peach nomenclature.

This omission of the newer sorts does not mean that they are not being planted, but it probably does indicate that growers generally are not yet satisfied that the recently introduced varieties are superior to those with which they are already familiar. Perhaps it may suggest also the desirability of greater familiarity on the part of peach growers with the more promising of the newer sorts. But variety testing is expensive. Not many commercial peach growers have either the time or the inclination to take up this type of work. Yet the only way in which the real value of a new variety can be determined is to grow it. The fact that a variety is adapted to the conditions in one region proves little or nothing with regard to its value in another region, where the conditions are different. In some of the important peach-growing districts, especially where there are good cooperative fruit-growers' organizations, a community variety-test orchard might be a practicable enterprise.

CLASSIFICATION.

In the present connection, only a brief mention of peach classification can be made. Probably the first system that was worked out is the one proposed by Mr. Gilbert Onderdonk, of Texas, and published by the Department of Agriculture in 1887.[1]

The basis of this classification is primarily regional, and the names applied to the classes or races largely represent the section of country

[1] See Report of the Commissioner of Agriculture, 1887, pp. 648–651. Considerable valuable information regarding peach classification has also been contributed by Prof. R. H. Price in Texas Agricultural Experiment Station Bulletin 39, entitled "The Peach."

in which the different races originated or from which they were disseminated. Though several modifications of the "Onderdonk system" of classification have been proposed, it is the one which is most widely recognized at the present time. The five races of peaches indicated in this system are (1) Peen-to, (2) South China, (3) Spanish, (4) North China, and (5) Persian.

The significance of these different races in the adaptability of varieties to the different peach-growing districts of the country is indicated in the following comments.

(1) *Peen-to race.*—The Peen-to race or group takes its name from the original variety, the Peen-to, which was introduced into this country in 1859 by the late P. J. Berckmans, of Augusta, Ga. With the exception of this member of the group, every variety which now belongs to it, according to Hume, has originated in Florida.[1]

These varieties are essentially adapted to subtropical conditions and very largely comprise the peach industry of the extreme southern portion of the country. Other important varieties of this group are the Angel, Bidwell Early, Bidwell Late, Clara, Hall, Jewell, Maggie, Suber, and Waldo. The characteristic shape of the Peen-to variety is shown by the small figure at the left in the illustration on the title-page.

(2) *South China race.*—The South China race is perhaps now more commonly designated as the Honey group,[2] the first variety of the group to be grown in the United States having borne that name. With few exceptions, the varieties which now compose this group have originated in Florida. Like the members of the Peen-to race, they are adapted to a subtropical climate, but their range of adaptability extends farther north than that of the members of the Peen-to race. They may be grown in central and northern Florida and in the southern parts of Georgia, Alabama, Mississippi, Louisiana, and Texas. Some of the more important varieties are the Climax, Colon, Florida Gem, Imperial, Pallas, Taber, and Triana. The characteristic shape of the Honey variety is shown by the small figure at the right in the illustration on the title-page.

(3) *Spanish race.*—The Spanish race was so designated by Mr. Onderdonk in his classification because he was unable to trace it with certainty farther back than Spain. The varieties that comprise this list, like those of the two races already discussed, are adapted to southern latitudes, but their range of adaptability does not extend as far south as does that of the members of those races. It does, however, reach somewhat farther north, as indicated by Onderdonk and others. Some of the varieties of this group as given

[1] For a full account of this group, see Florida Agricultural Experiment Station Bulletin 62, entitled "The Peen-to Peach Group," by H. Harold Hume.

[2] For a full account of the Honey group of peaches, see Florida Agricultural Experiment Station Bulletin 73, entitled "The Honey Peach Group," by F. C. Reimer.

by Price are the Cabler, Druid, Galveston, Guadalupe, La Reine, Onderdonk, Texas, and Victoria.

(4) *North China race.*—Because of the fact that the Chinese Cling variety of peach was the progenitor of the North China race in the United States, Powell[1] has suggested, with consistency, the term "Chinese Cling group" in place of the one originally used as the name of the race.

This group has assumed great importance because of the wide range of adaptability and great commercial importance of some of the varieties which are commonly designated as belonging to it. The trees of this group are generally hardy, vigorous, and spreading in habit of growth.

Chandler,[2] of the Missouri experiment station, has called attention to the fact that, as a rule, the varieties of this group are among the "slowest to finish their resting period."

Some of the most important varieties of this group are the Belle, Carman, Connet, Elberta, Family Favorite, Greensboro, Hiley, Lee, Lola, Mamie Ross, Ray, Rivers, Superb, Thurber, and Waddell.

It should be stated that several of these varieties, including the Elberta, are undoubtedly crosses between some member of the Chinese Cling group and one belonging to the Persian or some other group. In some particulars they resemble the latter parent. For instance, the Elberta is mentioned by Chandler as being an exception to the general rule that varieties of this group are slow in finishing their resting period. The fact that the Elberta starts quickly and is "tender in bud" is widely recognized. It is a seedling of the Chinese Cling crossed by a Persian variety—probably the Early Crawford. The general form of the Elberta is indicated by the largest figure in the illustration on the title-page.

(5) *Persian race.*—As the result of his investigations of the Persian race, Mr. Onderdonk concluded that—

> The race includes all varieties springing from the importation from Persia to Italy during the reign of the Emperor Claudius, which was introduced into Great Britain about 1550 and to the American colonies about 1680.

These varieties, as a rule, blossom relatively late. Many of them are grown extensively in the northern peach districts, as well as in middle latitudes. Some of the important varieties placed by Price in this group are the Crothers, Foster, Heath, Gold Drop, Late Crawford, Lemon Cling, Mountain Rose, Oldmixon Free, Reeves, Salway, Walker, and St. John.

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[1] See Delaware Agricultural Experiment Station Bulletin 54, entitled "The Chinese Cling Group of Peaches," by G. Harold Powell.

[2] See Missouri Agricultural Experiment Station Bulletin 74, entitled "The Winter-Killing of Peach Buds as Influenced by Previous Treatment," by W. H. Chandler.

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THE APPLICATION OF DOCKAGE IN THE MARKETING OF WHEAT

FARMERS' BULLETIN 919

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Markets

CHARLES J. BRAND, Chief

Washington, D. C. November, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

THE APPLICATION OF DOCKAGE IN THE MARKETING OF WHEAT.

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THE ATTENTION of the Department of Agriculture has been directed to certain misunderstandings that have arisen among buyers and sellers of wheat in connection with the assessment of dockage in the buying of wheat by grade in some sections of the country since the official grain standards of the United States for wheat became effective. Dealers in some localities where the factor of dockage was not a part of the grading system in the past have adopted certain unfair practices which they have alleged have been made necessary by reason of the inclusion of the factor of dockage in the official grain standards of the United States for wheat under the United States grain standards Act. It is believed, however, that most of the trouble which has arisen is the result of unfamiliarity with the application of the dockage principle and will disappear as soon as its use is more clearly understood. The purpose of this bulletin is to explain clearly to the grain farmers and dealers of the country the methods of determining dockage and its relation to the marketing of wheat under the United States grain standards Act.

WHAT DOCKAGE IS.

The order of the Secretary of Agriculture dated March 31, 1917, which fixed, established, and promulgated the official grain standards of the United States for wheat [1] refers to one of the factors taken into consideration in the official grades as "dockage," and defines it as follows:

Dockage includes sand, dirt, weed seeds, weed stems, chaff, straw, grain other than wheat, and any other foreign material, which can be removed readily from

[1] See United States Department of Agriculture, Office of Markets and Rural Organization, Service and Regulatory Announcements, No. 22, issued Mar. 31, 1917.

the wheat by the use of appropriate sieves, cleaning devices, or other practical means suited to separate the foreign material present; also undeveloped, shriveled, and small pieces of wheat kernels necessarily removed in properly separating the foreign material.

EQUIPMENT FOR SEPARATING DOCKAGE.

In determining the quantity of dockage in connection with the official grading of wheat the following cleaning devices are used in the Offices of Federal Grain Supervision of the United States Department of Agriculture (see fig. 1):

1. A small wheat tester or device for removing barley, oats, wild oats, pieces of straw, weed stems, and other coarse matter from wheat.

This is a modified form of the machine already in general use in the spring-wheat belt, where the dockage system has been practiced for many years. On account of the peculiar short, jerky motion of the riddle, this machine has been popularly designated as the "wild-oat kicker."

2. Set of perforated metal hand sieves consisting of—

(*a*) Bottom pan: Inside diameter of pan should be 13⅛ inches; depth, 2½ inches; and roll at top of pan $\frac{5}{16}$ inch in diameter.

(*b*) Buckwheat sieve: With triangular perforations $\frac{5}{64}$ inch long on each side of perforations; inside diameter of sieve should be 13 inches, depth 2 inches, and roll at top of sieve ¼ inch in diameter.

(*c*) Fine seed sieve: With round perforations one-twelfth inch in diameter. (Other specifications and dimensions same as for (*b*) buckwheat sieve above.)

(*d*) Fine chess sieve: With slotted perforations 0.064 inch wide by three-eighths inch long. (Other specifications and dimensions same as for (*b*) buckwheat sieve above.)

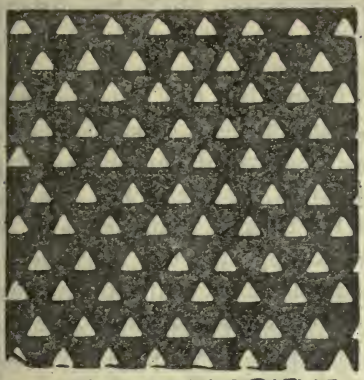
(*e*) Coarse chess sieve: With slotted perforations 0.070 inch wide by one-half inch long. (Other specifications and dimensions same as for (*b*) buckwheat sieve above.)

(*f*) Scalper sieve: With round perforations $\frac{13}{64}$ inch in diameter; depth of sieve should be 1½ inches; inside diameter 12⅞ inches; and roll at top of sieve $\frac{5}{16}$ inch in diameter.

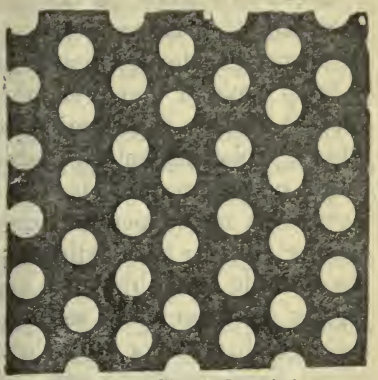
NOTE.—Sieves (*b*), (*c*), (*d*), and (*e*) should be made to nest very freely with the bottom pan. The scalper sieve (*f*) should nest very freely with each of the other four sieves and also with the bottom pan.

It is absolutely essential that the dimensions of the perforations of the sieves used be exactly as has been stated. A slight variation in the dimensions materially influences the percentages of dockage obtained. In order to secure the exact sizes it is necessary that the perforations be cut with dies especially made for the purpose. Sieves made from tin or galvanized iron with an ordinary punch will not give accurate results.

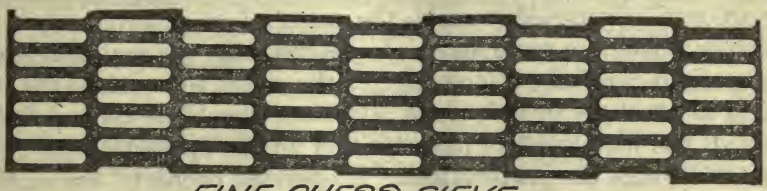
From experiments in hand screening and cleaning various kinds of foreign matter from wheat it has been found that with proper care metal sieves with perforations as indicated for hand sieves, used in connection with the wild-oats separator, will give a practical determination of dockage.



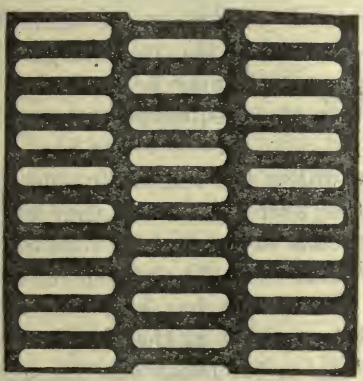
BUCKWHEAT SIEVE



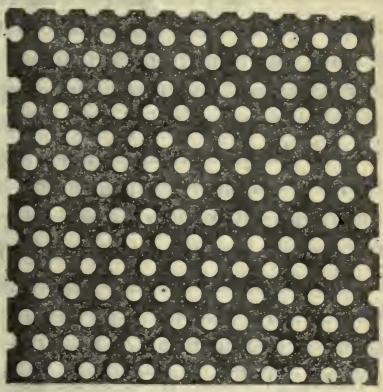
SCALPER SIEVE



FINE CHESS SIEVE



COARSE CHESS SIEVE



FINE SEED SIEVE

FIG. 1.—Illustrating the perforations (full size) of the dockage sieves adopted by the United States Department of Agriculture in connection with the enforcement of the United States grain standards act. Buckwheat sieve, triangular perforations 8/64 inch long on each side of perforation; scalper sieve, round perforations 12/64 inch in diameter; fine chess sieve, slotted perforations, 0.064 inch wide by 3/8 inch long; coarse chess sieve, slotted perforations 0.070 inch wide by 1/2 inch long; fine seed sieve, round perforations 1/12 inch in diameter.

METHOD USED IN DETERMINING DOCKAGE.

Great care must be taken that the sample on which the dockag determination is made is a representative, average sample of the lo or parcel of wheat which it represents.

Such sieve or sieves should be used in making this determinatio as will remove the foreign material with the least possible loss o wheat, including small, plump, or badly shriveled kernels, or larg pieces of broken kernels. As a general rule, the use of the fine see sieve with round perforations one-twelfth inch in diameter, and th scalper sieve or the "wild oat kicker" will be sufficient. However, i the sample contains an appreciable quantity of wild buckwheat pigeon grass, or other seeds of a similar character, or foreign mate rial, which will not pass through the fine seed sieve, then the buck wheat sieve should be used. All material passing through the buck wheat sieve should be considered as dockage, except that whenever the screenings removed by this sieve consist of an appreciable quan tity of small shriveled kernels, the material so removed should b rescreened over the same sieve. In rescreening, the material shoul be deposited carefully at one edge of the sieve; then, while the siev is held at an angle of 25° or 30°, the sieve should be tapped lightl until all the material has passed either to the opposite edge of th sieve or through the perforations. If operated properly, the materia at the opposite edge of the sieve will consist mainly of wheat an should be classed as wheat and not as dockage. The material tha passes through the sieve will consist mainly of wild buckwheat an other weed seed, together with a small percentage of shrivele kernels and small broken pieces of wheat, and all this material shoul be classed as dockage. In exceptional cases it may be necessary t repeat the rescreening in order to arrive at an equitable determina tion of the percentage of dockage.

The chess sieves should not be used unless the sample in questio contains an appreciable quantity of chess, keeping in mind that whea containing less than one-half of 1 per cent of dockage is considere as commercially clean wheat. As a general rule, the chess sieves like wise should not be used until after the sample has been screened either over the fine seed or the buckwheat sieve, as the sample ma require. Whenever it is necessary to screen for chess, the fine ches sieve with perforations 0.064 by $\frac{3}{8}$ inch should be used, except whe the sample consists of wheat of large kernels mixed with large ches seeds. Large chess seeds in a sample of wheat consisting mainly o small kernels from which the chess can not be separated readil should be considered as "inseparable" foreign matter and not a dockage, and the sample should be handled and graded accordingly

Whenever the fine chess sieve is used and the screenings consist of an appreciable quantity of small, shriveled, or split kernels, the material so removed should be rescreened over the same sieve by the same process as that described for rescreening over the buckwheat sieve. In rescreening over the chess sieve, the material should flow with and not across the slots.

The scalper sieve is to be used for removing coarse foreign material. Any thrashed wheat kernels that remain on the scalper sieve should be picked out and returned to the wheat and should not be considered as dockage.

The dockage, therefore, will be represented by the coarse foreign material and the finer screenings obtained by hand sieving. Since any foreign matter remaining in the wheat after the removal of dockage is considered as inseparable, and consequently directly affects the grade, great care should be used in sieving the samples.

The order of the Secretary of Agriculture previously referred to also requires that after the dockage has been properly determined—

The quantity of dockage shall be calculated in terms of percentage based on the total weight of the grain, including the dockage. The percentage of dockage so calculated shall be stated in terms of whole per centum and half per centum. A fraction of a per centum when equal to or greater than a half shall be treated as a half, and when less than a half shall be disregarded. The percentage of dockage so determined and stated shall be added to the grade designation.

VALUE OF DOCKAGE.

Ordinarily the dockage can be removed from the wheat with comparatively simple cleaning machinery, such as is installed in many of the country elevators and mills. Usually the dockage can be removed also with an ordinary portable fanning mill equipped with screens having perforations like those specified for the dockage sieves.

That part of the dockage which is not wheat not only has no value for flour-milling purposes, but often contains ingredients which are positively harmful when ground with the wheat.[1] However, the dockage found in wheat has in many cases a real value. This value depends on the nature of the material making up the dockage. Dockage frequently contains considerable quantities of nutritious weed seeds, wild mustard, flaxseed, wild oats, other grains, and undeveloped, shriveled, and small pieces of wheat kernels. Much of this material can be used to good advantage as poultry feed or feed for other stock. Such material as wild mustard and flaxseed can be removed from dockage in practically a pure state with special cleaning machinery, such as is usually found in the terminal elevators and

[1] The injurious effects on the milling and baking qualities of straight flour made from wheat containing various kinds of impurities are given in detail in United States Department of Agriculture Bulletin No. 328, entitled "Milling and Baking Tests of Wheat Containing Admixtures of Rye, Corn, Cockle, King Head, and Vetch," issued Dec. 30, 1915.

the larger flour mills handling wheat containing these ingredients, and, when so separated, command a good price on the market.

The farmer, of course, does not expect the grain merchant or miller to pay wheat prices for dirt, weed seeds, sand, chaff, and other foreign material found commonly in wheat. The grain dealer and miller can not and do not do this under any system of grading. When the dockage system of grading is not employed, the buyer takes into account the amount of foreign material found in the wheat and fixes the price at a figure which insures a safe purchase. In other words, a deduction is made in the price paid commensurate with the amount and kinds of foreign material present in the grain. Frequently, however, the grain merchant and miller buy all wheat as delivered at a flat rate, in which case the price paid is sufficiently low to protect the purchaser against losses due to foreign material delivered with the general run of grain. When the flat-rate method of purchase is followed, farmers with little or no dockage in their grain are obliged to sell at a comparatively low figure in order to protect the purchaser who receives from other farmers at the same price grain containing a considerable quantity of foreign material. When the dockage system is properly employed, the purchaser bases the price upon the intrinsic value of the grain as delivered. Therefore, the farmer who delivers grain with little or no foreign material in it receives full value for his product and is not obliged to take less than its worth in order that other farmers may receive the same market price for grain containing weed seeds and other foreign material.

METHODS OF HANDLING DOCKAGE.

The methods of handling dockage most commonly employed at present are the following:

(1) The wheat is cleaned on the farm, and only the clean wheat is hauled to market.

(2) The wheat as delivered to the country stations by the farmer is run over the proper cleaning machinery at the elevator or mill and the actual dockage is separated and returned to the farmer. It is the practice in some sections to make a small charge for such service, and in others to perform the service without cost to the farmer.

(3) The wheat is screened properly by the local buyer, payment is made to the farmer on the basis of the clean wheat only, and the dockage is retained by the elevator or mill as compensation for its service in removing it.

(4) The wheat containing the dockage is sold to the local buyer, who in turn consigns it to a commission man at a terminal market with the understanding that the commission man will secure the best

possible price not only for the wheat as if it were clean but for the wheat plus the value of the dockage which it contains.

The first two methods mentioned, in which only the screened wheat is delivered to the local buyer, tend to minimize the variation in the grade of wheat delivered by different farmers in the same locality and should result in greater confidence in the grades given by the local buyer. Furthermore, these methods enable the farmer to utilize the foreign material for feed or to sell it locally. The material so removed should be ground so as to destroy the vitality of the noxious seeds. In many cases such material, when removed, has a relatively high value as feed, and it is believed that farmers will find that it is often to their advantage to remove the dockage themselves or to have their local buyer do it for them, even though it may be necessary to pay a small fee for this service.

When the dockage is separated by the local buyer who retains it as compensation for the extra labor involved, as well as for compensation for the additional time and equipment needed by the elevator or mill to perform this service, as noted in the third method mentioned, it is allowed to accumulate at the elevator or mill and is either shipped to a terminal market in bulk, or, in cases of smaller accumulations, sacked and sold locally for feed. Such a method of handling dockage means, of course, that the total weight of the foreign material is donated by the farmer to the local buyer, and in many cases this foreign material has considerable value. This method may be a very efficient way of handling the entire factor of dockage in farmers' cooperative elevators where the farmer is financially interested. It means, of course, that whatever material of value there is in the dockage can be disposed of with the greatest efficiency and to the greatest advantage to all the farmers interested in the elevator and can be prorated back at the end of a season's business.

When wheat containing dockage is consigned to a commission man at a terminal market, as noted in the fourth method mentioned, the commission man under normal marketing conditions will sell the wheat by exhibiting a sample on the exchange floor, or otherwise, and secure the best possible price for the grain as it lies in the car. Consideration is given not only to the wheat itself but also to the wheat plus the dockage, provided, of course, that the dockage is of such nature that it has some commercial value in itself.

It is not unusual for a certain lot or parcel of wheat to contain a comparatively high percentage of dockage having a commercial value in itself. It is the function and duty of the commission man at the terminal market to obtain the greatest returns in such cases, and it is believed that in a large majority of cases this is done.

IMPROPER APPLICATION OF DOCKAGE SYSTEM.

One of the incorrect methods used by dealers in determining the amount of dockage has been arbitrarily to deduct a given amount by weight from all wheat purchased, regardless of the actual amount of dockage present. They have been doing this in lieu of providing themselves with proper facilities for accurately determining the percentage of dockage contained in the wheat. Information has reached the United States Department of Agriculture that in several localities this amount has been arbitrarily fixed as one bushel per wagonload of approximately 60 bushels. The practice is both unfair and unjust, and ultimately can not prevail. The taking of 1 bushel from a wagonload of 60 bushels is equivalent to a dockage of 1.66 per cent, while on the basis of 1 bushel in 50 it is equivalent to 2 per cent. Data which the department has gathered covering a period of five years relative to the dockage in wheat marketed in the localities in which this practice is at present prevalent show definitely that on the basis of the official grain standards of the United States for wheat approximately 25 per cent of the wheat received from the farmers in these localities is free from dockage, 25 per cent contains one-half of 1 per cent dockage, and the remaining 50 per cent shows a dockage ranging from one-half of 1 per cent upward. It is evident, therefore, that the practice of making an arbitrary assessment of dockage, regardless of the actual condition of the wheat, not only encourages the marketing of wheat containing weed seeds and foreign material but also greatly discourages general improvement in marketing conditions and good farming methods.

The department has also been advised that in some sections wheat buyers are first ascertaining properly the percentage of dockage in the wheat and deducting the weight of the dockage from the weight of the load. The buyers then determine the test weight per bushel upon the uncleaned wheat before the dockage is removed, and place their grade and consequent price upon the wheat in that condition in the same manner that they did prior to the time when the official grain standards for wheat were fixed. This is frequently unfair to the seller, for the reason that the test weight of wheat containing dockage usually will be lower than the test weight of the same wheat after the dockage has been removed. The standards specifically provide that each determination other than that of dockage for the purpose of these standards shall be made upon the basis of the grain when free from dockage. In other words, the grade of the grain, with the exception of dockage, should be determined upon the dockage-free grain.

The primary purpose in the passage of the United States grain standards act was to provide for the establishment of a single set of standards of quality and condition for grain to govern the grading thereof and to be applied uniformly to shipments in interstate or foreign commerce. Unfair practices such as those which have been described tend to defeat one of the wholesome ends sought in the broad application of the United States grain standards Act—improved conditions of marketing agricultural products. Such practices frequently occur at country points in connection with transactions which are purely intrastate in character. Unfortunately the criminal penalties of the grain standards act can not be administered to prevent them. The department, however, will do everything in its power to bring about the discontinuance of misrepresentations based on the act or the standards thereunder.

OTHER DETERMINATIONS MADE ON DOCKAGE-FREE WHEAT.

The standards provide that determinations made in connection with the wheat grades, with the exception of dockage, shall be made on the basis of the grain from which the dockage has been removed. In other words, the test weight per bushel, moisture content, damaged kernels, heat-damaged kernels, inseparable foreign material, odor, color and texture, temperature, general appearance, wheat of other classes and of subclasses, etc., must be determined on the basis of the wheat after the dockage has been removed.

It is unfair, therefore, for the purchaser to discount the seller for the weight of the dockage and at the same time make the weight per bushel test on the grain before the dockage is removed. Such a practice may result in a lower grade with a corresponding discount in price. The seller may therefore be subjected to two discounts from the basic price—one in the form of deduction in weight because of the presence of dockage and the other because of the lowering of the numerical grade on account of improper methods of making the test weight and other determinations.

CONCLUSIONS.

From the foregoing it would appear that the majority of the objections to the assessment of dockage have arisen through misunderstandings as to the proper methods of applying dockage to the grading of wheat.

It will be seen that dockage is an essential element in arriving at the true grade of wheat and that this dockage may consist either of useful or harmful foreign materials.

The United States grain standards act and the official grain standards of the United States for wheat do not in any way provide for an arbitrary discount for dockage or any other cause. The farmer who is called upon to accept such discount or deduction should not do so until he has first required the buyer to show that the discount or deduction is actually justified, including his authority for doing so.

The various methods of handling dockage should be carefully investigated and the one adopted which is best suited to the needs of the individual. It would appear advisable, when a large percentage of dockage is present in wheat, to remove it on the farm or at the point of shipment and thus avoid the payment of the freight rate for wheat on dirt, chaff, or weed seeds, etc.

It will be apparent that a correct dockage system in operation will protect the farmer from the possibility of low prices fixed by the buyer in order to insure a safe purchase, and that under the dockage system of grading the farmer should get a higher numerical grade for his wheat that contains dockage than he would under a system of grading which does not require a determination for dockage but which takes into account the total foreign material present in the determination of the numerical grade.

The primary purpose of the United States grain standards act is to establish a single set of standards of quality and condition for grain, and it is believed that after a careful reading of the facts set forth in this bulletin it will be evident that the operation of a correct system of dockage plays an important part in obtaining this result, in so far as wheat is concerned.

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MILK GOATS

EDWARD L. SHAW
Animal Husbandry Division

FARMERS' BULLETIN 920
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Animal Industry
JOHN R. MOHLER, Chief

Washington, D. C. February, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

THE PRODUCTION of milk goats has for a great many years been an important feature of the live-stock industry in many European countries, but it has never secured a very strong foothold in the United States. In this country the goat has always been an animal of more or less ridicule, as the majority of the people do not realize the possibilities of certain breeds or types that have been bred for many years along definite lines.

In continental Europe milk goats are largely used by families unable to keep a cow, and great benefit is derived from having fresh milk at hand and at a low cost. In those countries the goat is often spoken of as the "poor man's cow."

During the past several years considerable interest has been manifested in the milk-goat industry in this country. The fact that the goat will supply sufficient milk for the average family and can be kept where it would be impossible to keep a cow is beginning to appeal to many people, especially those living in the small towns and the suburbs of the large cities.

The milk-goat industry is only in its infancy in America. This type of goat is adapted to our country, and the industry should become of greater importance every year.

MILK GOATS.

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PRESENT STATUS OF THE INDUSTRY.

THE MILK-GOAT industry in the United States has not as yet developed to any important extent. The interest shown during the past has come largely from people who were either raised in or at least are familiar with conditions in countries where the milk goat has proved a success. It requires time to educate people to the value of any new industry, especially one that has been so greatly handicapped as has been the case with the milk goat. In Switzerland, Italy, Germany, France, Norway, and Spain milk goats are largely used by families not so situated as to permit keeping a cow. F. S. Peer, a well-known American importer of live stock, after making an investigation of the industry in Switzerland some years ago, stated that "the goat of Switzerland is the Swiss peasant's cow and Swiss baby's foster mother, a blessing to the sanitariums for invalids, and a godsend to the poor."

In England and in many other parts of Europe people who leave the cities during the summer months either for their country homes or for travel often take a milk goat with them so that the infant or other members of the family may have a good supply of milk of uniform quality. Similar instances have been recorded in this country. No other animal is so well adapted for such a purpose, and there is probably no other country where goats are so much needed for such a purpose as in the United States.

The industry in the past has been greatly handicapped owing to the scarcity of good goats for foundation herds. Only a few goats have been imported, as will be noted later in discussing the different breeds. Importations can not be made at the present time from most of the countries where desirable goats are produced. But the goats that have been imported have been quite widely distributed and most of them seem to have done well under their new environment.

The milk goat is adapted to this country and the industry is likely to become of greater importance every year. The goat is especially useful to those who desire a small quantity of milk and do not have the room, or can not afford, to keep a cow. In fact, a goat can be kept where it would be impossible to keep a cow, and it will consume considerable feed that otherwise would be wasted. The fact that goats are rarely affected with tuberculosis is another point in their favor. The demand for good goats appears to be far greater than the supply.

GOATS' MILK.

YIELD.

About the first question that most people ask concerning milk goats is, "How much milk will they produce?" This is, of course, a very important consideration, as the value of a doe is estimated largely by her milk production. Even if a doe is pure bred, she is of little value from the utility standpoint unless she is capable of giving a good quantity of milk. Many persons in purchasing pure-bred or even grade goats have been disappointed to find that the milk could be measured in pints and not quarts or gallons as expected.

A doe that produces 3 pints a day is considered only a fair milker, while the production of 2 quarts is good, and the production of 3 quarts is considered excellent, provided the lactation is maintained for from 7 to 10 months. There is probably no better way to treat this matter than to state that good does should produce from 8 to 15 times their weight in milk in a lactation period. It is stated by German writers that many goats yield 10 times their body weight of milk annually, and exceptional animals as much as 18 times their weight. The production of some of the goats in this country will be noted in the section dealing with the different breeds and types.

PRICES.

The price to be obtained for goats' milk depends upon a number of conditions. If the milk is to be sold for ordinary uses the price will, of course, be much lower than if a special market has been developed. In the past the price has ranged from 10 to 50 cents a quart, and the highest prices have been obtained when the milk has been supplied for the use of infants and invalids. The demand and the cost of production will serve as a guide as to what price should be obtained. Just as long as good goats are scarce and high-priced it will be necessary to get good prices for the products, whether in the form of milk or cheese, to encourage people to engage in the industry.

It will be of interest to note that there is a brand of evaporated unsweetened goats' milk upon the market that retails for 20 cents a can of 11 ounces, which is equivalent to about 30 cents a quart for the original milk.

CHARACTERISTICS.

Goats' milk is nearly always pure white in color. The small size of the fat globules is one of its chief characteristics. The cream rises very slowly and never as thoroughly as in the case of cows' milk. This condition makes the ordinary method of obtaining the cream impracticable. It has been stated that goats' milk will not keep sweet as long as cows' milk, but tests have been made that show that this is not the case. The keeping quality of any milk depends upon the conditions under which it has been produced and handled.

In tests made by the Department of Agriculture, it was found that goats' milk could be thoroughly separated in a separator, for when milk testing 4.4 per cent fat was run through the separator the skim milk showed only 0.03 per cent of fat.

If goats' milk is properly produced and handled, there should not be any goaty odor. The principal source of the bad flavor and odor in the milk is the dirt and hair which fall into it from the body of the animal. Then again, the goaty odor is often absorbed by the milk when the milking is done near where the bucks are kept.

COMPOSITION.

At the New York Agricultural Experiment Station, at Geneva, N. Y., with a mixed herd of goats, it was found that the percentage of fat in the milk varied from 3.2 to 4.4 per cent; the solids (not fat) ranged from 7.72 to 8.61 per cent; and the total solids ranged between 11.4 and 11.9 per cent.[1] The composition of milk from the Bureau of Animal Industry's herd of the common American type of goats, as determined by tests made by the Dairy Division, averaged as follows: Specific gravity, 1.0338; fat, 5.99 per cent; total solids, 16.96 per cent; solids not fat, 10.97 per cent; sugar, 4.93 per cent; total protein, 4.63 per cent; and water, 83.04 per cent. For comparison the following averages of over 5,000 analyses of cow's milk at the New York station are given: Fat, 3.9 per cent; total solids, 12.9 per cent; solids not fat, 9.0 per cent; sugar, 5.1 per cent; and water, 87.1 per cent.

At the New York station a chemical study of goats' milk indicated no essential difference between the constitution of its casein and that of cows' milk. Marked differences were observed in the salts of the ash as compared with the ash of both cows' milk and human milk, but the effect of these differences has not been fully studied.

GOATS' MILK PRODUCTS.

Goats' milk can be utilized for the same purposes as cows' milk, although for some it is not nearly so well suited. For general use, such as for drinking, cooking, and in tea and coffee, the milk has

[1] Bulletin 429, New York Agricultural Experiment Station, Geneva, N. Y.

proved very satisfactory. The milk of one of the largest herds in the country is evaporated and sold in that form. Goats' milk is less satisfactory than cows' milk for making butter, but large quantities of goats'-milk cheese are manufactured, especially in Europe. Practically all publications dealing with milk goats attribute considerable importance to the use of the milk for infants and invalids.

BUTTER.

Good butter can be made from goats' milk, but ordinarily very little is produced. The cream rises very slowly, and only a portion of it reaches the top. By the use of the separator, of course, practically all the butterfat could be secured. Unless artificially colored, the butter is very white, and resembles lard in appearance. If colored, it resembles cows' butter in appearance, although it does not have the same texture. It can be used for the table or for cooking. Tests made by the Bureau of Animal Industry proved that a good quality of butter could be produced when the milk and cream were properly handled and no objectionable features were present. It should be noted, however, that when a good price is obtained for the milk, it would not pay to make butter, as cows' butter could be purchased much cheaper.

CHEESE.

Several varieties of cheese, known under various names, are made from goats' milk. In France, goats'-milk cheese is called cheveret, or chevrotin; in Italy, formaggio di copra; and in Germany, Weichkäsen aus Ziegenmilch (soft cheese from goats' milk). Goats'-milk cheese has a characteristic and individual flavor all its own, although the product closely resembles Limburger cheese. It is made either entirely of goats' milk or, better, with from one-fourth to one-third cows' milk; the mixture materially improves the quality of the product. The manufacturing process is simple and requires no special equipment other than a few special forms and a curing room which can be kept at a temperature of 60° F.

The fresh milk is set with commercial liquid rennet for about 45 or 50 minutes at a temperature of from 86° to 90° F. It is perhaps advantageous to add a 1 per cent starter. Rennet is diluted about 20 times in cold water and added at the rate of 1 cubic centimeter (25 drops) to 10 pounds of milk. After a thin film of whey has collected upon the firm coagulated milk it is cut by means of a cheese knife into pieces about the size of a walnut. After the curd has remained in the whey for five minutes it is gently stirred for an equal length of time, and then placed in forms by means of a cup or a long-handled dipper. These forms are made of 3X tin, and are 4½ inches in diameter by 5 inches high. Each form has five rows of holes, the holes being about an inch apart and one-eighth of an inch in diameter.

The curd remains in the forms undisturbed until it acquires a consistency that will admit of turning. After from 24 to 36 hours at a temperature of 70° F. salt is applied to the surfaces, and the cheese is left on draining boards for about 24 hours. It is then placed on plain boards and carried to the curing room, which should have a temperature of 60° F. and a high humidity.

A blue mold first appears on the cheese, and should be removed by brushing with a moistened cloth. A slimy, reddish growth, which appears to be needful in bringing about the proper ripening changes, then covers the cheese. While the curd is at first sour, it gradually becomes less so, and finally develops a sweet and agreeable flavor. When the acidity has disappeared, the cheese is in suitable condition for wrapping.

The cheese may be wrapped in parchment paper alone or in parchment paper and tin foil; the combination seems to be more desirable, as the tin foil aids in preventing desiccation, promotes ripening, and gives the package a more attractive appearance. The cheese should then be put into regular Camembert boxes. It should take five or six weeks to ripen, and when ripe should have a fine, white color and an agreeable flavor. About 4½ pounds of milk are required to make each cheese, which when fully ripe weighs about half a pound.

A fairly satisfactory cheese may be made from goats' milk by a method similar to that outlined in Bulletin 79 of the Storrs (Conn.) Agricultural Experiment Station.

The type of Roquefort cheese made from goats' milk is quite different in both flavor and texture from that made from sheeps' milk.

MILK FOR INFANTS AND INVALIDS.

A great many cases in which goats' milk has proved especially valuable for infants and invalids are on record. In many of these cases other foods had been tried and did not seem to agree with the patients. The following is taken from Bulletin 429 of the New York Agricultural Experiment Station under the heading "Summary":

Extensive study of the use of goats' milk in infant feeding by Drs. Sherman and Lohnes, of Buffalo, showed that the curds of goats' milk when returned from the stomach were smaller and more flocculent than those of cows' milk. From the determination of the combined hydrochloric acid in the returned food, the authors conclude that the cows' milk had a greater stimulating effect on the stomach than goats' milk. The absorption of the food and gain in weight in comparing the two milks were indefinite for several reasons. The babies tolerated equally well similar amounts of goats' milk with cows' milk when used with the same diluents. The younger the child the more the evidence pointed toward a greater gain on goats' milk.

Goats' milk was supplied to 18 cases of children that were not thriving on any other food that had been tried. In 17 cases a satisfactory state of nutrition was established through the use of goats' milk, the beneficial results in some instances being very marked. With certain of these children their situation was regarded as serious, and their restoration to a satisfactory nutritional condition was good evidence that goats' milk is often a very desirable resort for infant feeding.

In a project carried on cooperatively by the Sea View Hospital, New York, and the Bureau of Animal Industry, the value of goats' milk for tuberculous patients was investigated. The cases treated were all pulmonary tuberculosis varying from quiescent with slight infiltration to active, far-advanced cases with extensive infiltration and cavitation. Adolescents were preferably chosen, irrespective of sex, and in order to have as many as possible under treatment at the same time, some were accepted as low as 6 years of age. A control was selected for each case whose condition closely resembled the one under treatment.

The results showed that the goats' milk cases and the controls progressed about the same. Ten of the sick cases under treatment showed a definite improvement, while 11 of the controls were improved. The bed cases were not weighed, but the ambulant patients were weighed weekly and showed that the treated and the controls gained about the same weight. These results are therefore entirely negative.

The question of the transmission of a passive immunity to tuberculosis by the transfer of natural antibodies from goats' milk to very young infants or from the use of this milk over a much longer period is a subject of investigation at present incomplete.

GOAT DAIRIES.

During the past few years a number of goat dairies have been in operation in different parts of the country. These dairies have been established both for the purpose of producing milk and the manufacture of cheese. The largest goat dairy in the country, however, is devoted to the manufacture of condensed milk. If only a few goats are kept it is not necessary to have much in the way of equipment, but if a considerable number of does are milked it is best to have the proper equipment for handling the work advantageously. This does not mean, however, that expensive buildings must be provided. Any clean, dry quarters free from drafts may be used.

The essentials of a dairy are facilities for the proper handling of both the goats and the milk. This means that the building should have proper ventilation, plenty of light, and arrangements made so that each goat can be properly fed and handled. The illustrations given of the dairy of the Bureau of Animal Industry, located at Beltsville, Md., give a good idea of how to handle a medium-sized herd (see figs. 1, 2, and 3). As will be noted in looking over this plan, there are pens where the does may be handled together and stalls where they can be fed individually. The does have leather collars about their necks and are tied to the mangers in the stalls by means of a short rope with a snap on the end which fastens to the ring in the collar. At kidding time small temporary pens are easily made by the use of

hurdles and can be utilized as long as necessary. After the does have kidded and the kids are ready to be taken away, the does are transferred to the stalls. Until the kids are at least a month old they are fed and handled in the temporary pens.

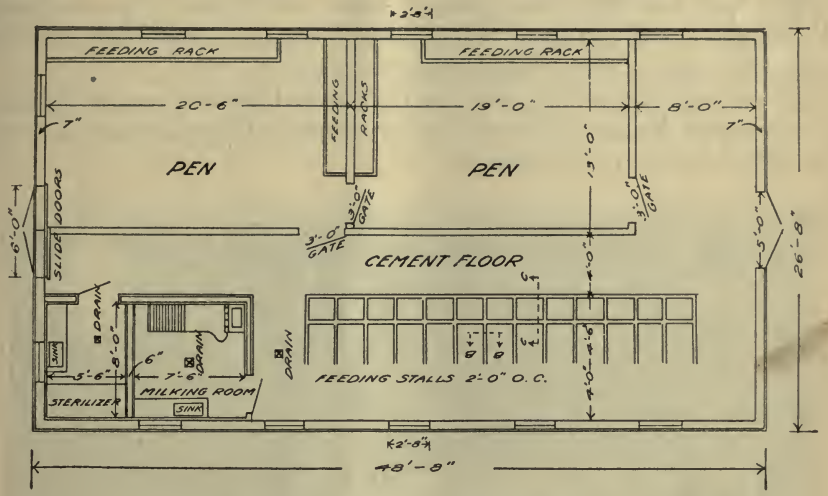

FIG. 1.—Plan of goat dairy at Bureau of Animal Industry experiment farm, Beltsville, Md.

The milking room is separated from the main room and has a concrete floor with the walls and ceiling concrete-plastered so that they can be kept clean by flushing out with the hose. This room is equipped with a sink, milk scales, and milking stand. The milk is handled in another room called the milk room. This room is equipped with a

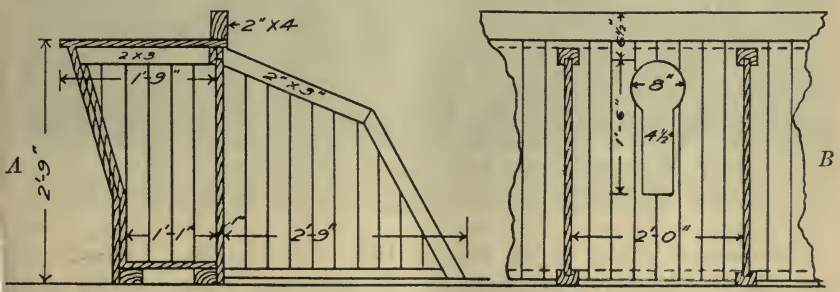

FIG. 2.—*A*, side view of single stall and manger; *B*, division between stall and manger. The opening allows the goat to feed and prevents all waste of feed.

cooler, a sink, and a sterilizer. The grain is kept in the feed bins at the east end of the main dairy. Hay is stored in another near-by building.

BREEDS AND TYPES OF GOATS.

Although there are many breeds and types of milk goats in the world, only a few of them have been imported to this country. This

is largely due to the fact that there has been a quarantine against most of the countries where the milk-goat industry is one of the important phases of live-stock production. It is not known just how many goats of each breed or type have been imported. Many immigrants have brought young goats in baskets with them when entering the country. Then again many goats have been imported and the breed or type was not stated upon the records.

The breeds that will be discussed in this publication are the Saanen, Toggenburg, Nubian, Maltese, Schwartzenberg-Guggisberger, and the so-called common or American.

FIG. 3.—Goat dairy of the Bureau of Animal Industry at Beltsville, Md.

SAANEN.

The Saanen is one of the leading breeds and takes its name from the Saanen Valley of Switzerland. It is said to be the largest of all the Swiss breeds. Although considered a hornless breed, occasionally an animal is found with horns. The color ranges from a pure to a creamy white. The dairy conformation is especially well developed in the Saanen breed. The hair is usually short, with the exception of a strip along the spinal column extending to the flanks and the hind quarters. A Saanen buck is shown in figure 4, and does of this breed are seen on the front page.

The first record of the importation of Saanen was in 1904, when 10 head came in through the Canadian quarantine. These goats were

selected in Switzerland by F. S. Peer, and were imported for other persons. R. N. Riddle, of New Jersey, imported 20 head in 1905. An importation of 19 head was made in 1906 by Fred Stucker, of Ohio. The latest importation was of 2 head in 1913 by Mrs. Lee, of Toledo, Ohio.

Very little information is available regarding the milk production of the Saanen breed. The bureau has not yet owned any pure-bred does. Reliable breeders have stated, however, that their best does have produced from 6 to 9½ pounds a day during their best period of lactation. A pure-bred doe at the New York Experiment Station, at Geneva, produced an average of 1,421.6 pounds a year for three years. In 1911 she produced 1,845.2 pounds. This is an especially good record.

FIG. 4.—Saanen buck owned by the Bureau of Animal Industry. Age, 2 years 4 months; weight, 132 pounds.

At the Bureau of Animal Industry's Experiment Farm, Beltsville Md., Saanen bucks have been used for crossing on the common American type of does with excellent results. The Saanen is a very prepotent breed, and in crossing with common does not only is the Saanen color obtained, but the size, conformation, and mammary development show great improvement over the common goat.

Cross-bred Saanen does have a longer period of lactation than common goats, which is of considerable importance. From records kept regarding the Government herd, these cross-bred and grade does have milked from 7 to 10 months after kidding and produced an average

of 3.1 pounds of milk a day. Some of the best averaged about 4 pounds a day for 10 months. The butterfat in the milk has ranged from 4 to 6 per cent, with an average of 5 per cent.

In comparing the results of crossing or grading with Saanen and Toggenburg bucks in the bureau's herd, it was found that the Saanen produced the larger kids, but the Toggenburg-bred does have been more prolific and have produced a little more milk, which also tested a trifle higher in butterfat.

The average weight of mature half-blood Saanen does in the bureau's herd in 1917 was 129 pounds. This weight was taken

FIG. 5.—Toggenburg buck owned by the Bureau of Animal Industry. Age, 2 years 3 months; weight, 151 pounds.

about three months after kidding, when the does were in good milking condition.

The Saanen is without question one of the most beautiful and valuable breeds, and as the supply of pure-breds is very limited in this country it will be necessary to grade up herds from common stock by using Saanen bucks of the best breeding obtainable.

TOGGENBURG.

The Toggenburg is one of the leading breeds of Switzerland and takes its name from the Toggenburg Valley, where they have been bred for a great many years. Although generally considered a

hornless breed, occasionally one is found with horns. F. S. Peer, after a trip in the Toggenburg Valley, stated that he did not see a specimen with horns, owing no doubt to the prevailing custom there of weeding out those that developed horns. The color of the Toggenburg is brown with a light stripe or bar down each side of the face. The legs below the knees and hocks are light gray or almost white. The wattles or appendages, two in number, attached to the under side of the neck, are very characteristic of this breed.

There are really two types of the Toggenburg , the short-haired and the long-haired. Mr. Peer stated after visiting the Toggenburg Valley in 1904 that he was not able to get a positive answer that one type was any hardier than the other.

FIG. 6.—Toggenburg doe.

The first record of importations of the Toggenburg into the United States was in 1893, when W. A. Shafor, of Hamilton, Ohio, imported 4 head from England. In 1904 F. S. Peer imported from Switzerland for other persons 16 head, which later became widely distributed. The largest importation of milk goats ever made to this country was in 1905, when R. N. Riddle, of New Jersey, imported 119 Toggenburgs. These goats were sold over a wide territory. Another importation of 9 head was made in 1905 by F. S. Peer. In 1906 Fred Stucker imported 13 head. The latest importation was one buck from the West Indies by Dr. Gregg, of California, in 1916.

The Toggenburg is the most numerous as well as the most popular of the breeds of milk goats in this country. For this reason more has been heard about it and more data are available concerning it. The breed is especially noted for milk production. It is claimed that in Switzerland Toggenburg does produce from 4 to 5 quarts a day, and some of the best even more. Reliable breeders in the United States report does producing from 3 to 5 quarts a day during the best period of lactation, while a few does have averaged from 2½ to 3 quarts for a period of from 8 to 10 months. A pure-bred doe in California, weighing 160 pounds, is credited with the production of 2,096 pounds of milk in 10 months. Another doe owned by the

FIG. 7.—Half-blood Toggenburg doe No. 114; out of common American doe No. 66 (see fig. 11). Produced 1,429.3 pounds of milk, testing 5.5 per cent fat, in 365 days.

same person is credited with producing 2,680 pounds in a lactation period. This doe weighed only 136 pounds.

At the United States Experiment Farm, Beltsville, Md., the Bureau of Animal Industry has used Toggenburg bucks in crossing on the common American type of does with excellent results. The Toggenburg is an especially prepotent breed, and the cross-bred or grade offspring not only take of the Toggenburg color and markings but show great improvement in conformation and mammary development. Records kept of the Bureau's herd show that the cross-bred or half-blood Toggenburg does have milked from 6 to 10 months after kidding and produced an average of 3.2 pounds of milk a day.

Some of the best does have averaged 4½ pounds a day. The butterfat has ranged from 4 to 6 per cent; the general average for two years has been 5.2 per cent.

The average weight of the mature half-blood Toggenburg does in the bureau's herd in 1917 was 103 pounds. This weight was taken about three months after kidding when the does were in good milking condition.

The Toggenburg is a very prolific breed; records for three years in the bureau's herd show a little over 200 per cent increase.

Owing to the fact that Toggenburg goats are more plentiful in this country than other breeds, a good many grade goats of the Toggenburg type are found in various parts of the country. In fact, many herds have been established by crossing Toggenburg bucks upon does of the common American type.

NUBIAN.

The Nubian, although considered a valuable breed, is found in but small numbers in this country. It is a native of Nubia, Upper Egypt, and Abyssinia. Its important peculiarities consist in the length of the large drooping ears and the shape of the head. The outline of the face is convex, the forehead being especially prominent, while there is a depression at the nostrils and the lower jaw projects slightly beyond the upper. The ears are wide at places and of such length that they hang below the jaw and turn slightly upward at the ends. The Nubian is considered a hornless breed, but bucks occasionally develop horns. It is one of the largest breeds of goats. The hair is short and fine, and owing to this condition this breed is less hardy than the leading European breeds and can not stand extreme cold. The color is black, dark brown, or tan, with or without white markings. Pure-bred Nubian bucks are said to be free, or nearly so, of the odor so prevalent in the males of other breeds.

The Nubian breed is very prolific and one of the best for milk production. Nubian bucks have been crossed on common does with very satisfactory results.

An importation of 4 Nubians was made to this country from Mexico by W. W. Carr, of Virginia, in 1909. These goats came from France to Mexico.

The Anglo-Nubian, which is a very popular type of goat in England and is found in some sections of the United States, is a cross between the Nubian and the native English goat. These goats are large and valuable for milk production. There is no special fixed color. Black, tan, and red, with or without white, seem to predominate. Occasionally some of the goats are found that are either spotted or piebald. All goats of Nubian breeding have similar characteristics.

In 1896 G. Howard Davison, of New York, imported 4 English goats. It is very likely that these were of the Anglo-Nubian type. In 1909 4 Anglo-Nubians were imported from England by R. I. Gregg, who also imported 2 from England in 1913. In 1906 D. C. Mayers, of Virginia, imported 7 grade goats from Barbados. Some of these goats were of Nubian breeding.

The Bureau of Animal Industry has never experimented with the Nubians or goats of Nubian breeding, and so can not give results such as are mentioned for some of the other breeds.

FIG. 8.—Nubian buck.

MALTESE.

Although considered a valuable breed of milk goat, the Maltese is of no special importance at the present time in this country, except that it has had some influence on the type of goats in the Southwest. As the name signifies, it is a native of the Island of Malta.

This breed is kept in large numbers on that island. It is usually hornless, but occasionally one is found with horns. The ears are rather long and are carried horizontally. The udders are quite large and in many instances almost touch the ground. The hair is rather long, the color being white and reddish brown or black. For milk production this breed is considered one of the best.

For a number of years there has been a type of goats in the Southwestern part of the United States known as the Spanish Maltese. It is claimed that at a former time many Maltese goats were taken into Spain and later found their way to Mexico and finally to Texas and New Mexico. This type of goats is white or grayish in color, but many have brown, bluish-black, or reddish spots. The ears are pendulous. No reliable information is at hand regarding milk production, although it is claimed that some are very good producers.

FIG. 9.—Maltese goats.

SCHWARTZENBERG-GUGGISBERGER.

The Schwartzenberg-Guggisberger breed was originally from the Simmen Valley of Switzerland. Although it is represented in the United States in only very small numbers, the writer believes that it might prove to be valuable if a sufficient number could be obtained to give it a thorough trial.

This breed is not only of good size, but the does show a very good dairy conformation. Hilpert describes it as being built like the Saanen, of fawn color or brownish white, and of very large size. He also says that it is excelled by no other breed of goats in milk production when under good care and feed. A pure-bred doe at the New York Experiment Station produced an average of 730.8 pounds of milk a year for three years. The same doe produced 913.3 pounds in 1911.

An importation of 3 head of these goats was made in 1906 by Fred Stucker, of Ohio.

The general conformation and the leading characteristics may be noted from the illustration (fig. 10).

COMMON, OR AMERICAN.

Either of the names "Common" or "American" may be applied to a large number of short-haired goats found in many sections of the United States, especially in the South. In many sections these goats have been bred for a great many years without the introduction of outside blood, so that in general conformation they are very uniform.

They are of medium size and somewhat short legged, rather meaty in appearance, and do not show the conformation of the Swiss breeds.

FIG. 10.—Schwartzenburg-Guggisberger doe.

Although a few goats of this type are occasionally found that are good milkers, the quantity produced is usually small and the lactation period is for only a few months. One of the greatest objections from the standpoint of utilizing this type of goat for milking is the fact that the teats are usually short and small. Both sexes as a rule have horns; those on the bucks frequently attaining a good size. This type of goats is of various colors; brown of various shades, brown and white, black and white, bluish gray, and white predominate.

The Bureau of Animal Industry selected a shipment of common short-haired goats in the South in 1909 for the purpose of testing them for their milk production. It was found that the does not only pro-

duced a rather small quantity of milk, but the average lactation period was short. In 1915, 10 of the best selected does produced milk for periods of from 7 to 10 months and gave from 1 to 2 pounds of milk a day. The average production for the 10 does was 1½ pounds. The per cent of butterfat ranged from 6.5 to 9.4, the average being 7.6 per cent.

These goats are very prolific. In 1912 the rate of increase was a little over 250 per cent, while for a period of several years it was 225 per cent.

Owing to the scarcity of good milk goats, the common or American type properly selected offers a good foundation for grading up with either the Toggenburg, Saanen, or Nubian breeds.

Since it would require many years to build up a good milking type by the use of the common goats alone, and such excellent results were obtained by crossing Saanen and Toggenburg bucks upon them, the the bureau discontinued the use of the common goat in 1913.

Large numbers of goats have been brought in from Mexico, and these have no doubt had some influence upon the type found in many parts of the South and Southwest.

METHODS OF BREEDING.

SELECTION OF THE BUCK.

A buck is always considered half the herd, and in order to make progress in breeding care should be exercised in making a selection. As good bucks are scarce, it is not always possible to procure the type desired, but the best obtainable should be procured even if the cost be a little greater. Select a buck from a good producing doe and a persistent milker. There is nothing so important in the matter of breeding as evidence that the entire family to which the sire belongs is especially good in conformation as well as in performance. The success of breeding any class of animals depends largely upon the selection of the sires. The selection of a single sire has made many herds famous.

A buck should be masculine in appearance, of at least medium size for his age, and of good conformation. As regards the latter, a good depth of body is one of the most important considerations. The masculinity of the buck can be, of course, determined by the size and conformation of the head, size of the legs, amount of beard, and the quality and length of the hair on various portions of the body. The legs should be straight and well placed Always select a vigorous buck. Thinness is no objection if the buck is healthy and a good feeder. A good buck is seldom in good flesh, especially during the breeding season.

Most breeders at the present time prefer bucks that are naturally hornless. Such bucks are usually prepotent and sire most of their

kids without these appendages. The class of does to which the buck is bred will of course have some influence in this respect.

In cases where only a few does are kept, it would be not only cheaper but more convenient to send them away to be bred. A buck is usually a troublesome individual and must be kept away from the rest of the herd. Many of the leading breeders breed outside does, and the charges made are usually very reasonable.

Many small breeders are compelled to use cross-bred or grade bucks; in such cases selections should be made upon conformation and breeding.

FIG. 11.—Common American doe No. 66. Dam of doe No. 114, shown in fig. 7. Produced 367 pounds of milk, testing 7.6 per cent fat, in a lactation period of 275 days.

SELECTION OF THE DOE.

Although it is not always possible, it is much more satisfactory in making selections to see does during their lactation period. This not only gives an opportunity to study their conformation when they are producing, but the udder development, which is so important, can be better considered.

A good doe should have a feminine head, thin neck, sharp withers, well-defined spine and hips, thin thighs, and rather fine bone. The skin should be fine and thin when examined over the ribs. She should have good digestive capacity, as shown by the spring of rib and size of stomach. The so-called wedge shape of the dairy cow

is clearly defined in a good milk doe. The constitution, an important item, is defined by the depth and width of the chest. The udder should be of good size when filled with milk and very much reduced when empty. A large udder does not always indicate a high milk yield unless it is of the so-called "genuine" type. The teats should be large enough to make milking easy.

In selecting a doe the first questions that are naturally asked are, How much milk will she produce and how long will she milk? While some does will milk for only a few months after kidding, others will continue producing for 8 to 10 months or even longer.

In selecting does, especially when they are giving milk, avoid those that are fleshy; this is a strong indication that they are not good producers. Select those of the dairy conformation.

Owing to the scarcity of good does, both grades and pure-breds, and the prices asked for them, it is much more economical to start by selecting good common does, such as are found in many sections of the country, and breeding them to bucks of the leading breeds such as those mentioned before.

AGE FOR BREEDING.

Goats are in their prime when from 4 to 6 years of age, but choice individuals and good breeders may often be kept to good advantage several years longer. As a general rule young does should not be bred until they are from 15 to 18 months of age, at which time they will be practically grown if they have been well cared for. As most breeders have their does kid in the months of February, March, and April, and breed them but once a year, it means that the doe kids dropped during these months should be bred the second fall after birth. Owing to the fact, however, that some people who only keep two or three does desire a milk supply during the entire year, it would be necessary to breed for both fall and spring kidding. The same would be true where goat dairies are operated. In such cases young does, well grown, can be bred to good advantage when from 12 to 15 months of age.

The bureau has found that the number of does that will breed in the spring for fall kidding depends a great deal upon the season. More does were bred in 1915 and 1917 than in 1916. Not many does come in heat in the spring.

Does will breed when quite young, and care should be taken not to allow them to become pregnant too young. Cases are recorded where does have kidded when less than nine months of age.

PERIODS OF HEAT.

Does come in heat at all times of the year, but not frequently between the 1st of March and the middle of August. When they come in heat and desire the attention of the buck, they make their

condition known by uneasiness and constant shaking of the tail. They usually remain in heat from 1 to 2 days. The period between heats varies from 5 to 21 days. From the record kept of the bureau's herd, more does have returned in from 5 to 7 days. Those that run over this time usually go from 18 to 21 days.

Bucks are continually in heat from the fall to the spring season. It is during this time that they have such a strong odor. The number of does to breed to one buck depends upon his age and condition. An early spring buck kid, if well grown and properly handled, can be bred to a few does the following fall. A buck from 12 to 18 months of age can be bred to at least 25 does, while a mature buck is sufficient for from 40 to 50 does.

GESTATION PERIOD.

The gestation period, which is the time between the effective service of the buck and the birth of the kid or kids, ranges from 146 to 152 days. It is usually spoken of as five months. The average gestation period for several years in the bureau's herd with does of several types has been 149 days.

NUMBER OF KIDS.

Milk goats are very prolific. As a rule, very few single kids are produced. The usual number at one time is two, but frequently there are three, and it is not a rare thing, especially among the common American goats, to have does produce four. The annual rate of increase in the Bureau's herd for the past six years with does of several types has been a little less than 200 per cent.

FEED AND MANAGEMENT.

THE BUCK.

In handling goats the buck problem is one of considerable importance. It is the strong odor and the disgusting habits of the bucks that cause many people to take a great dislike to goats. Bucks should be kept away from the does except when desired for service. If they are kept in the same barn or room where the does are milked some of the strong odor is very likely to be absorbed by the milk. The place for the bucks is in a separate barn or shed, with a sufficient lot for exercise and pasture.

The best results can be expected only when the bucks are kept in a healthy condition. During the winter months the ration should consist of either alfalfa, clover, or mixed hay and corn stover, with some succulent feed in the way of silage, turnips, etc., and a sufficient quantity of grain.

For several seasons the bucks in the Bureau's herd have been wintered on 3 pounds of alfalfa or clover hay, 1 to 1½ pounds of silage or turnips, and 1½ pounds of grain per day, the grain mixture consisting of 100 pounds of corn, 100 pounds of oats, 50 pounds of bran, and

10 pounds of linseed-oil meal. During the breeding season the grain ration for mature bucks is usually increased to 2 pounds. When the bucks are out on good pasture, no grain is necessary.

During the breeding season, it is usually necessary to keep the bucks separate or they will fight and are likely to injure each other. A wood lot with plenty of browse is an excellent place for the bucks during the summer. It must be noted that goats are browsers by nature and they prefer leaves and twigs and weeds to grass. The common short-haired American goat or any of the milk breeds are just as valuable for clearing land as the Angora.

Under the conditions which many people keep goats it is necessary to protect the trees in the lots and pastures by putting around them a framework covered with close-woven wire. This is especially true of the young trees. If no lot is available for feed and exercise, the buck can be tethered out. This system is practiced by many people who have only a small lot. Vacant lots can very often be utilized to good advantage for this purpose. Fresh feed as well as a variety would thus be afforded.

THE DOES.

Most of the feeds that are valuable for the production of milk for the dairy cow are also suitable for does. It is ordinarily considered that from 6 to 8 goats can be kept upon the feed required for one cow. When does are in milk, they should be allowed all the roughage that they will consume, such as alfalfa, clover, or mixed hay and corn stover. They should receive a liberal quantity of succulent feed, such as silage, mangel wurzels, carrots, rutabagas, parsnips, or turnips. The grain feeds best suited for their ration are corn, oats, bran, barley, and linseed-oil meal or oil cake. Other feeds that are often available and that can be utilized are cottonseed meal, brewer's grains, corn bran, gluten feed, and beet pulp.

A ration that has been used in the Bureau's herd and proved very satisfactory for does in milk during the winter season has consisted of 2 pounds of alfalfa or clover hay, 1½ pounds of silage or turnips, and from 1 to 2 pounds of grain. The grain ration consisted of a mixture of 100 pounds corn, 100 pounds oats, 50 pounds bran, and 10 pounds of linseed-oil meal. When the does are on pasture they receive from 1 to 1½ pounds of grain per day of the mixture mentioned, with the exception of the linseed-oil meal.

It must be noted, however, that there is a great difference in individual goats; one goat may readily eat a ration that another may not like so well. As in the case of dairy cows, each doe should be studied if the best results are to be obtained. It is best, of course, to feed separately each doe giving milk. This not only gives an opportunity to study each individual but also insures that each one receives the quantity intended for her.

In 1916, in the Bureau's herd, with 10 half-blood Toggenburg and half and three-quarter blood Saanen does, during their lactation period it required 1.21 pounds of grain to produce a quart of milk.

During the fall and early winter the pregnant does should be allowed all the roughage they will consume, together with 1 pound of silage or roots and 1 to 1½ pounds of grain of the same mixture as mentioned for does in milk. Care should always be taken to see that the silage is of good quality; it should not be fed if frozen or moldy. Silage and turnips should always be fed after milking, and if any silage remains in the trough uneaten it should be removed. Pregnant does require plenty of exercise to produce strong, healthy kids.

It is safe to figure on 300 pounds of hay and 450 pounds of grain a year for a mature doe; that is, of course, assuming that good pasture is afforded as much of the year as possible. The New York Experiment Station at Geneva reports in Bulletin 429 that the average cost of feed per goat for the year 1912 was $11.05. The California station reported in Bulletin 285 that the average cost per year for each of 5 pure-bred and grade does kept at the station in 1914 was $11.24. This agrees very closely with the cost at the Geneva station. The average cost of the feed needed to produce 1 gallon of milk in this experiment was 6.4 cents.

Young does should be kept growing, and the quantity of feed needed will depend upon certain conditions. In the spring, summer, and fall, if they have plenty of browse and pasture, no grain is necessary. If no browse is afforded and the pasture is short during certain months it is best to give them a little grain. In winter they should be fed about 1 pound of grain, 1 to 1½ pounds of silage or roots, and all the hay or fodder they will consume. They should have a shed for shelter and protection from the wind. Goats must be kept dry and out of the cold winds.

Some goat breeders make it a practice to gather leaves in the fall and store them for winter use. This is a very good practice, as the leaves are not only readily eaten by the goats but can be used for bedding. If only one or two goats are kept, refuse from the kitchen, such as potato and turnip peelings, cabbage leaves, and waste bread may be utilized for feeding. If necessary, does can be tethered out as mentioned for the buck.

All feed offered to goats should be clean. Rations should be made up from the best feeds available and those most relished by the goats. Plenty of rock salt should be kept before the goats, and a small quantity of fine salt should occasionally be mixed with the grain fed. A good supply of fresh water is necessary; goats should not be compelled to drink from pools where the water has been standing.

LACTATION PERIOD.

The lactation period, which is the time that a doe produces milk, varies considerably in the different breeds and types of goats. It ranges all the way from 3 to 10 months, or even longer. A lactation period ranging from 7 to 10 months is considered very satisfactory. There are certain conditions which may have an influence upon it, such as the breed, individuality, health, feed, and regularity and thoroughness of milking. Pure-bred does of any of the leading breeds will, as a general rule, milk longer than any of the so-called common, or American, type. The breed that has been developed the longest should, of course, excel in this respect if the animals have been properly selected. There are always individuals in a breed that excel along certain lines, and this is especially true as regards the lactation period.

The health of the does while giving milk is of especial importance. Does when out of condition will frequently shrink in their milk yield and in many cases have to be dried up. Proper food and regular feeding have a tendency to extend the lactation period by not only stimulating the production but causing a more uniform flow during this time. The milking must be done regularly and thoroughly if good results are desired. Irregularity and neglecting to draw all the milk from the udder has a tendency to shorten the period.

MILKING.

As goats are small animals, they can be milked to much better advantage when upon a stand such as shown in figure 12. As young does usually object to being milked at first, the stanchion arrangement shown in the illustration is an excellent method of handling them. For the first few times at least it is best to give the does a little grain feed in the box attached to the stanchion. Does soon become accustomed to being milked and after a few times will jump upon the stand and put their heads through the stanchion without being assisted.

The doe's udder should always be either washed or wiped thoroughly before being milked. Ordinarily a damp cloth will be sufficient to remove all foreign material. The first milk drawn should not be saved, as the openings in the teats may be partially filled with foreign matter and this will be removed after a little milk has been drawn. It is best to have a room for milking separate from the main goat barn. This prevents the milk from absorbing any goat odors that might be present.

There are two systems of milking goats, one when the milking is performed from the side, as is practiced in milking cows, and the other from the rear of the goat. It is claimed that the second system is used because the goat can not be trained to set her right hind foot

FIG. 12.—Milking stand and method of milking in the herd of the Bureau of Animal Industry, Beltsville, Md.

back as a cow is trained to do. Many of the does in the bureau's herd, however, have been trained to keep the right hind foot back while being milked.

FIG. 13.—A Pennsylvania goat dairy, showing method of milking.

There are also two systems of drawing the milk from the udder—one consists in pressing the teat in the hand, as is usually practiced in milking cows, and the other in "stripping." The first can be adopted when the teats are of sufficient size to be grasped by the hand. The other method is followed by most goat milkers and is a very satisfactory way of milking. The teat is grasped between the first finger and the thumb close to the udder and drawn down the entire length, sufficient pressure being exerted to cause the milk to flow freely.

A heavy producer may have to be milked three times a day for a short time, but twice is sufficient for most does. The period between milkings should be divided up as nearly equally as possible. Milk should not be used for human consumption until the fourth or fifth day after the doe kids. Some authorities recommend waiting for a longer period, but this is not necessary if everything is normal. Regularity in milking is important, and kindness and gentleness should be regarded as essential in the goat dairy. It is advisable that the milking be done by the same person as much as possible.

FIG. 14.—Milking pail used in the Bureau's dairy. Capacity, 4 quarts.

It may be stated as a matter of interest that in some of the European countries goats are driven through the streets from door to door and the milk is drawn by the goatherd as ordered by the customers.

CARE OF THE MILK.

All utensils used in handling the milk should be kept clean. As soon as the milk is drawn it should be weighed, strained, and cooled. The weighing is necessary if it is desired to determine accurately how much the doe produces. Milk records are especially valuable to the breeder in selling stock as well as in his breeding operations.

The milk should always be thoroughly strained to remove any foreign matter in it. The best method is to use a layer of sterilized absorbent cotton between two cloths, or to pass the milk through several thicknesses of cloth. Cheesecloth is the best for this purpose.

To check the growth of bacteria the milk should be cooled to a temperature of 50° F. as soon after milking as possible. This may be

done by placing the cans in a tank containing cold water. One of the best systems of cooling the milk rapidly, however, is to run it over a cooler inside of which is cold, running water. Milk should be kept cool until wanted for use. Complete information on the production of clean milk is contained in Farmers' Bulletin 602.

RAISING THE KIDS.

The raising of the kids is especially an important consideration when it is desired either to sell or use the milk for family purposes. Those, however, who do not care to raise the kids can easily dispose of them when a few days old. Kids that are allowed to suck their dams will not only make a good growth but require very little attention as compared with those raised by hand

The amount of milk to be fed and the length of time that it should be fed depends upon several conditions. Kids dropped in the spring will not require as much milk and need not be fed for as long a time

FIG. 15.—Half-blood and three-quarter-blood Saanen kids.

as those dropped in the fall or early winter. The quantity of milk required for a kid can be determined readily from the fact that a doe producing from 3 to 4 pounds of milk a day can easily raise two kids very satisfactorily. This means that each kid would receive 1½ to 2 pounds of milk a day, or, in other words, 1½ to 2 pints. The bureau has tried an experiment in allowing several does with records of a little over 4 pounds of milk a day to suckle three kids. The kids made a fairly good growth, which shows that when some hay and grain is added it does not require as much milk as might be supposed.

Kids that are to be raised by hand should be allowed to remain with the doe for two days. This gives them an opportunity to obtain the colostrum milk which is so valuable for them.

Kids can be raised satisfactorily on skimmed cows' milk, and some goat breeders adopt this system. They should be changed from whole to skim milk very gradually, the quantity of skim milk

being gradually increased until it makes up the entire milk ration. After this has been done the kids will usually consume from 2 to 3 pounds a day. They should be given just as much as they will readily drink, and until they are at least six weeks old they should be fed three times a day. During this time the milk should be warmed and fed at a temperature of 90° F. They can be weaned from milk when they are from 3 to 4 months old. At this age they will consume sufficient hay, grain, or pasture to make a good growth. Some of the leading goat breeders do not wean the kids until they are about 5 months of age. The age for weaning, however, depends

FIG. 16.—Feeding kid with milk from pan; method followed in the Bureau's herd.

upon the system of raising the kids. If raised by nursing the does, they can be allowed to go for the 5 months, but if raised on skim milk and the supply is limited they can be weaned much earlier.

Kids will eat a little hay and grain at an early age, and they should be provided with them. Alfalfa or clover hay should be given in a rack and the grain mixture in a trough. Arrangements should be made so as to keep the kids out of both the rack and the trough. A good grain ration for the kids consists of cracked corn, crushed or rolled oats, and bran mixed in the proportion of one part cracked

corn, one part crushed or rolled oats, and one-half part bran. They should be allowed as much as they will clean up in a reasonable time.

If the kids are fed by hand, they can either be given the milk from a bottle, using a nipple, or a tank with a number of nipples attached, or they may be fed from pans. The bureau has adopted the pan and trough system, and this has proved very satisfactory. The kids can easily be taught to drink from a pan, and the system is much less troublesome than using a bottle and nipple. Cleanliness is absolutely essential for the successful raising of kids. See that the pans, pails, bottles, and nipples are kept clean. After the kids are a few weeks old they can drink from a galvanized iron trough. Care should be exercised, however, to see that each kid receives its share of the milk.

Kids are very playful creatures and require considerable exercise. If they are kept in a small inclosure, it is a good plan to put a box from 18 to 20 inches in height in the center, so that they may run and jump upon it. This will not only afford them considerable amusement, but will give them plenty of exercise, and they will have keen appetites for their feed. Pasture or browse should be afforded as early as possible.

CASTRATION.

All buck kids not desired to be kept or sold for breeding purposes should be castrated when they are from 10 days to 3 weeks of age. The older they become the more severe the operation. The operation of castration is very simple and can be performed best by cutting off the lower third of the scrotum with a clean, sharp knife, forcing the testicles down and pulling them away, one at a time, with the spermatic cords attached. If, however, the kids are over 4 months of age, the cords should not be pulled out, but scraped off just above the testicles. The wound should be bathed after the operation with some good disinfectant.

Buck kids should be separated from the doe kids when they are about 4 months of age. Doe kids come in heat when quite young, and the young bucks worry them a great deal when allowed to run with them. Occasionally doe kids become pregnant when they are only from 4 to 5 months of age.

MARKING.

Each goat in the herd should be marked in some manner for identification. This may be done by the use of metal ear labels, by notching the ears, or by tattooing the ears. In some instances all three of these systems are used. When this is done, the kids' ears are notched as soon after birth as possible, and when they are from 3 to 6 months of age the ear label is inserted and the tattooing done. The ear label is not only numbered, but has either the initials or

name of the breeder upon it. The only objection to its use is that it is likely to be torn out. Care should always be taken to insert the label rather close to the head and far enough up into the ear to make it fairly tight.

Notching the ears can be done with the punch used for inserting the ear label. Notches upon certain parts of the ears indicate certain numbers, the sum of the numbers represented by the notches being the number of the goat. Numbers up into the hundreds involve a rather complicated system, but these are not usually necessary in a small herd. To avoid a complex system, each crop of kids may be numbered from one upward. The notch system is especially valuable, as it not only serves as a means of identification but it is not always necessary to catch the goats to read their numbers. A person can stand some distance from the goat, and if the goat is facing him the notches can readily be seen.

Tattooing on the inside of the ear is a very satisfactory method of marking goats, especially those having light-colored ears. Tattooing instruments are upon the market, having adjustable numbers and

FIG. 17.—Methods of marking goats' ears. *a*, Metal label; *b*, notching; *c*, tattooing.

letters, with which a combination containing three or four of either or both can be made. Some breeders tattoo their initials in one ear and a number in the other. Tattooing is an excellent method of checking on the ear label, as the same number as is on the label is usually tattooed. India ink, both stick and liquid, special tattooing oil, and indigo can be used for pigment.

DIPPING, DEHORNING, ETC.

When goats are infested with lice, as they sometimes are, they should be either dipped or washed. If the herd contains only a few head, it is not necessary to go to the expense of dipping, as a careful washing will gain the desired results. Any good, reliable stock dip as advertised upon the market will answer the purpose. The main thing is to follow the instructions regarding the use of the dip selected. Methods of dipping sheep, as described in Farmers' Bulletin 798, "The Sheep Tick," may be followed in the case of goats.

Mature goats may be safely dehorned. This is done best by sawing the horns off close to the head with a common meat saw. The operation should be performed if possible when the weather is fairly

cool and when flies are not troublesome. As soon as the horns are removed it is well to apply a little pine tar to the wounds.

The horns on kids can be prevented from developing by using either caustic soda or caustic potash, which may be obtained from the drug store in the form of sticks about the thickness of a lead pencil. These caustics should be used with care, as they may injure the skin of the person handling them. The stick caustic should be wrapped in a piece of paper to protect the fingers, leaving one end uncovered. Moisten the uncovered end and rub it on the horn buttons. Care should be taken to apply the caustic to the horn button only, but it should be blistered well. The application should be made when the kids are from 2 to 5 days old.

FIG. 18.—Type of goat fence used at the Bureau of Animal Industry's experiment farm, Beltsville, Md.; 42 inches high. (This fence appears also in the background of fig. 12.)

The best fence for inclosing goats is of woven wire, ranging in height from 42 to 48 inches. Care should be taken, however, to have the ends of the braces against the end posts low enough so that the goats can not walk up them and jump over.

If goats are more or less confined and not allowed to run upon gravelly or rocky soil their hoofs grow out and should be trimmed. This can be done with either a sharp knife or a pair of small pruning shears.

GOAT MEAT AND GOATSKINS.

There has always been a rather general prejudice in this country against the use of goat meat as food. However, in some sections a great many goats of the milk type, especially kids, are annually con-

sumed. In some parts of the South kids are considered quite a delicacy and are in demand. They are sold for slaughter when from 8 to 12 weeks of age. The flesh of young goats, or kids, is palatable and has a flavor suggesting lamb. If properly cooked, the meat from a mature milk goat is also good eating, provided the animal has been properly fed and is in good condition.

The prices of goats sold on the market for slaughter are always considerably less than those received for sheep. Goats do not fatten and carry flesh like sheep. Nevertheless it is known that thousands of goats, both old and young, are annually slaughtered and their meat sold as mutton and lamb.

Owing to the fact that the United States imports in normal times upward of 40,000,000 goatskins annually, it would naturally be supposed that there should be a ready market for all skins that could be produced. Skins from the short-haired goats, such as the common type of American goats of the milk breeds, are the kind used in the manufacture of shoes, gloves, book bindings, pocketbooks, and like articles. As a rule goatskins from the short-haired goat are worth from 25 to 50 cents each. However, in large lots and properly prepared for sale they will bring a higher price. The price depends upon the size and condition of the skin.

PRICES OF GOATS.

Owing to the excellent demand and the limited supply of milk goats, breeders are naturally asking good prices for stock. Pure-bred bucks of any of the leading breeds cost from $25 to $100, depending, of course, upon the breed, age, conformation, and breeding. Good bucks from record-producing does are usually held at a higher figure. Grade or crossbred bucks may usually be purchased for from $10 to $25. Bucks of such a breed as the Nubian are very scarce and the prices asked for them are usually high.

The prices for does not only depend upon the breed, age, conformation, and breeding, but upon milk production. Pure-bred does cost from $25 to $150, while grade or crossbred does range from $5 to $50. Persons who wish to procure a milking doe to furnish milk for an infant or an invalid are only too glad, as a rule, to pay a fair price and do not care so much about the breeding of the goat. It is largely milk production in the doe that establishes her value.

In some herds, where breeders do not care to raise all the kids and desire to dispose of them as soon as possible after birth, the prices range from a few dollars up to $10 a head.

RENTING GOATS.

It occasionally happens that a supply of goats' milk is desired for only a short time. Under such conditions does are sometimes rented. Sometimes a breeder would not care to sell a doe but would be willing to rent her out. The charges for this service not only depend upon the value of the doe and the quantity of milk she is capable of producing, but upon how badly the goat is needed. The writer recalls one case where a doe was rented for a period of three months at $10 a month, and in case of the death of the doe the owner was to receive her full estimated value. However, a fair basis for the charge of renting out a doe would be a reasonable price per quart for the milk she would likely produce during the period wanted.

GOAT TROUBLES.

Although considered very healthy, goats are subject to disease and have their troubles as well as any other class of animals. Goats are less subject to disease than sheep, but the two species are so closely allied that the treatment in cases of disease is the same for both.

A matter of great importance and one upon which breeders lay considerable emphasis is the fact that goats are rarely affected with tuberculosis. Their freedom from this widespread and dreaded disease is probably due to environment rather than to natural immunity. When confined to close quarters with cows that have tuberculosis, they will, however, contract the disease. Goats that are in good condition are not very likely to be diseased or to contract disease, but there are some maladies which affect them if they are allowed to get in poor condition.

In the Federal meat inspection the cause of most of the condemnations for goats on both ante-mortem and post-mortem inspections is emaciation. Emaciation may be due to any one or a combination of several conditions or diseases, such as stomach worms, flukes, tapeworms, abortion, and takosis. It is necessary, of course, to find out the real cause of this condition before a treatment can be administered.

STOMACH WORMS.

Goats become infected with stomach worms, the important symptoms of which are loss of flesh, weakness, digestive disturbances, diarrhea or constipation, capricious appetite, and paleness of the mucous membranes of the eyes and mouth. Swellings under the jaw are often noticed. Stomach worms are found in the fourth stomach; they are rather small, ranging from ½ to 1¼ inches long and about as thick as an ordinary pin.

There are two methods of treatment, one with the use of gasoline and the other with copper sulphate (bluestone or blue vitriol). Tests made by the Zoological Division of the Bureau of Animal Industry indicate that in sheep the gasoline treatment is not only less efficacious

and more troublesome than the bluestone or copper sulphate, but is liable to have a more injurious effect upon the animal. The evening before the animals are to be treated they should be kept off feed and water and the medicine administered the next morning.

To prepare the copper-sulphate solution dissolve 1 ounce of copper sulphate into 3 quarts of water. Avoid copper sulphate which shows white patches. The solution is administered as a drench. A kid 3 months old should be given three-fourths of an ounce, at 6 months 1½ ounces, at 12 months 2½ ounces, at 18 months 3 ounces, and at 24 months 3½ ounces.

Common salt acts to a certain extent as a preventive against infestation of internal parasites, and the importance of this should be kept in mind in handling goats.

The best method of avoiding loss from internal parasites is by good feeding and the use of a series of pastures arranged so as to avoid keeping the animals too long on the same ground, which as a result of contamination with the droppings from goats harboring the parasites becomes more and more heavily infested the longer it is used for grazing. Where the goats can browse normally there is little danger, but when they are kept on grass pastures the danger increases. Bureau of Animal Industry Circular 157 discusses the life history of the stomach worm and methods of preventing its injurious effects.[1]

TAKOSIS.

Takosis is a disease which played havoc some years ago in a number of Angora herds. The disease has occurred in a few herds of milk goats and is one that is to be greatly dreaded. The symptoms are somewhat similar to those accompanying a parasitic invasion of diarrhea and pneumonia. The disease is discussed in Bureau of Animal Industry Bulletin 45.[2]

MALTA FEVER.

The disease known as Malta fever has been endemic on the island of Malta for many years, and its presence in other parts of the world has been recognized from time to time. In the United States it has been found in Texas and New Mexico. Its origin in these States is indefinite, but it is stated that it prevailed in Texas when the common goat was the only type in the country. The disease can be transmitted to man. In localities where the disease is prevalent it is considered best to heat the milk before using it. Bureau of Animal Industry Circular 215 discusses this disease.[3]

[1] This circular may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents.

[2] For sale by Superintendent of Documents, 10 cents.

[3] For sale by Superintendent of Documents, 5 cents.

ABORTION.

Abortion occasionally occurs in the herd. It may be caused by a injury of some kind or it may be of the contagious nature. If a do aborts she should be placed in a pen by herself, away from the re mainder of the herd. The fetus and afterbirth should be buried o burned. The doe should be washed out daily with a good antisepti solution and the pen thoroughly disinfected. It may require severa weeks for the doe to return to normal condition.

MINOR AILMENTS.

Constipation.—Constipation sometimes occurs, especially with th kids. A dose of Epsom salt or castor oil will correct this trouble.

Lice.—Goats frequently become infected with lice. This matte is treated on page 31, under dipping.

Caked udder, or garget.—Caked udder, or garget, is something tha should be looked after very carefully. When this condition i present the udder feels hard and is hot. The best treatment is t bathe the udder thoroughly several times a day with warm water an after thorough drying with a cloth rub on a little lard. It is wel also to give a dose of Epsom salt.

Sore teats.—This condition may be caused either by the teeth of th kids, warty growths on the teats, or an injury. After washing an drying the teats carbolated vaseline should be applied.

Foot rot.—Unless properly managed, goats may have foot rot The first evidence of this trouble to attract attention is a slight lame ness, which rapidly becomes more marked. The foot will becom swollen and warm to the touch. The best method of treatment is b the use of sulphate of copper (blue vitriol). The solution is prepare by dissolving 1 pound of copper sulphate in 5 quarts of water. Th goat should stand in the warmed solution for several minutes.

MILK GOAT REGISTRY ASSOCIATIONS.

The American Milch Goat Record Association was organized i 1903. The object of the association was to establish and improv the breeds of milk goats in America; to collect information of th history and pedigree of the best milk goats wherever found and t preserve the record of the same; to publish as much of such informa tion as shall be deemed advisable by the board of directors; to ex hibit milk goats at such times and places and under such regulation as may be decided upon by the directors. The first volume of th register of this association, published in 1914, records 900 head J. C. Darst, Dayton, Ohio, is the present secretary.

The International Nubian Breeders Association was organized i 1916. The object of this association is to promote the interests o the Nubian breed. Archie C. Talboy, Room 512 Central Mortgag Building, San Diego, Cal., is the present secretary.

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THE PRINCIPLES OF THE LIMING OF SOILS

EDMUND C. SHOREY
Scientist in Charge of Chemical Investigations

FARMERS' BULLETIN 921
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Soils
MILTON WHITNEY, Chief

Washington, D. C. March, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

THE APPLICATION of lime to soils brings about beneficial results in several ways. It stimulates the proper decomposition of the organic matter in the soil, neutralizes acids in the soil, improves the physical condition of heavy soils, supplies lime to growing plants, or makes available other elements in the soil.

The great majority of the soils of the East, South, and portions of the Central West are deficient in lime and will respond in increased yields to applications of lime.

In the following pages information is presented regarding the materials used in liming, their preparation and use, as well as a discussion of the chemical changes brought about in the soil by lime, so far as they are known. The relative merits of different forms of lime are discussed and data furnished whereby the value of any particular form of lime for agricultural purposes may be determined approximately.

The bulletin has been prepared primarily from the point of view of materials used in liming and of the principles involved in their use.

THE PRINCIPLES OF THE LIMING OF SOILS.

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INTRODUCTION.

THE PRACTICE of applying lime to soils for the purpose of increasing crop yields has been more or less common in many parts of this country since its first settlement, has been followed in many parts of Europe for centuries, and dates back more than 3,000 years.

The term liming as generally used means the application to the soil of the element known to chemists as calcium in one of two forms—either calcium carbonate, more commonly known as carbonate of lime, or calcium oxide, the ordinary burned lime of commerce. Carbonate of magnesium mixed with carbonate of lime, as in dolomitic or magnesian limestone, and the mixed oxides resulting from burning such limestones are included also under the term lime.

MATERIALS USED IN LIMING.

CARBONATE OF LIME.

Carbonate of lime occurs in nature in several forms, of which ordinary limestone and marl are the most common. Marble, chalk, coral, and oyster and clam shells are forms not so widely distributed. All of these forms when properly prepared are suitable for agricultural use.

Limestone.—Limestone is one of the most common of rock formations; and although its appearance probably is familiar to everyone, some other rocks are so similar that they are sometimes mistaken for it. Limestone may vary in color from a very light gray to almost black, with shades of red or brown in some cases, and may vary considerably in hardness. It may be distinguished from other rocks of similar appearance by the fact that it effervesces—gives off bubbles of gas—when a drop of dilute acid (muriatic acid) is applied to it.

Limestone is prepared for direct agricultural use by grinding or pulverizing, and when so prepared is marketed as ground limestone,

pulverized limestone, or sometimes under proprietary or trade names that do not indicate its composition. In chemical composition limestone is essentially carbonate of lime, but it varies in its content of this principal constituent from 95 per cent or more to less than 80 per cent, and occasionally as low as 60 per cent. The average content of carbonate of lime probably is about 83 per cent. The impurities present are small quantities of a large number of minerals, none of which can be considered of any agricultural importance except as so much inert material that must be hauled and handled when a limestone of low grade is used. Except on land in the immediate vicinity of the limestone deposit, limestone containing less than 80 to 85 per cent of carbonate of lime is not generally used.

Magnesian limestone.—The term magnesian limestone is applied to one that contains both carbonate of lime and carbonate of magnesia. The term "dolomitic limestone" also is applied to the same material. In appearance it often can not be distinguished from ordinary limestone. Usually it does not effervesce on the application of dilute acid at ordinary temperature, but does so on warming. The value of this limestone for agricultural use is usually considered as equal to that of ordinary limestone, that is, one containing 85 per cent of lime and magnesia carbonates would be equal in value to an ordinary limestone containing 85 per cent of carbonate of lime.

Marl.—Marl, as the term is most commonly used, is a form of carbonate of lime that has been deposited from water. It occurs frequently as a deposit under other material or in the beds of streams or lakes. It is usually in a more or less finely divided condition, but sometimes the material has become more or less cemented and requires grinding before it can be used. Marl is more variable in its content of carbonate of lime than is limestone, and the impurities present are usually clay or silty material. In some sections the term "marl" is applied to greensand material containing glauconite, a mineral which contains potash. The content of carbonate of lime in greensand usually is rather low. Marl sometimes has an advantage over limestone where carbonate of lime is to be used in that it may not require grinding, or at most may require only a mashing of the more or less friable lumps and is naturally in a finely divided condition. Except for this its value as compared with ground limestone should be judged by its content of carbonate of lime. In some localities are found deposits of shells partially disintegrated and more or less cemented together. Such deposits often are called marl or shell marl. Frequently they are hard and require grinding before they are suitable for agricultural use.

Marble.—Marble is the same in chemical composition as high-grade limestone. It is too valuable for other purposes to be available for

agricultural use, but sometimes small quantities of marble waste are available for this purpose.

Coral.—Coral is the skeleton remains of marine organisms and is essentially carbonate of lime. Where coral deposits have become elevated above sea level, the surface material where exposed may become weathered so that it is soft and friable, much like marl in character. Below the surface, however, it usually is hard and compact and must be ground. Supplies of coral are of limited extent in the United States, being confined to portions of Florida and Hawaii. Where available it may be considered of the same value as limestone or marl of the same content of carbonate of lime. In the vicinity of coral formations beach sands frequently occur that are made up of coral fragments mixed with small shells. This so-called coral sand is variable in its content of carbonate of lime, but is of value as a source of material for liming in proportion to this content.

Oyster and clam shells.—Oyster shells and clam shells when cleaned of adhering dirt and organic material contain 90 to 95 per cent of carbonate of lime. When coarsely ground they are extensively used for poultry feed, in the preparation of which the finer material is sometimes sifted out and offered for agricultural use. Such material may contain all the sand and dirt that accompanied the shells. Clean shells when burned or when finely ground constitute a very valuable, although limited, supply of lime for agricultural purposes, and when ground to the same degree of fineness they may be considered as of the same agricultural value as other forms having the same content of carbonate of lime.

Chalk.—Chalk is material that has been deposited in much the same way that marl has been. It is very free from impurities, being in most cases nearly pure carbonate of lime. Chalk has been used somewhat extensively in agriculture in some countries, but deposits in this country are of insufficient extent to warrant considering it a source of material for liming. Deposits in this country that usually are known as chalk more properly should be called marl.

Waste lime.—In many industries there are waste products containing oxide of lime or lime carbonate that frequently can be obtained and used locally at small cost. Such products are the lime from gas works, paper mills, tanneries, water-softening processes, spent calcium carbide, and slags from iron or other works. These may contain other compounds that might be injurious to vegetation and their freedom from these should be assured before they are used. Such materials usually contain excess of moisture and can not profitably be shipped without previous drying, and their value for agricultural purposes depends not only on their content of lime oxide or carbonate but also on their freedom from injurious compounds.

OXIDE OF LIME.

Oxide of lime is marketed in several forms, all of which are derived from some form of carbonate of lime by heating or burning. By this process carbonic acid is driven off, leaving the oxide. Any of the forms of carbonate mentioned can be used for the manufacture of the oxide, but as a matter of fact, except for a small quantity obtained by burning oyster shells, all calcium oxide is made from limestone. The purity of the product obtained depends on the purity of the limestone used, since nothing is removed by the burning except the carbonic-acid gas.

FIG. 1.—A kiln for burning oyster shells.

Burned lime.—The term "burned lime" is applied to the ordinary lime prepared by burning limestone in lumps. The terms "quicklime," "caustic lime," "lump lime," and "builder's lime" are also applied to this material. In burning the limestone retains to a large extent the lump form in which it was placed in the kiln and the product is marketed in that form in bulk or in barrels.

Ground lime.—The term "ground lime" is applied to lump or burned lime that has been finely ground but has had no other treatment.

Hydrated lime.—When oxide of lime is treated with water, chemical combination takes place; heat is generated and the lump falls to a powder quite as dry in appearance as the original oxide, if no more than the proper quantity of water has been used. This process is called slaking and the product is known as slaked lime, calcium-hydroxide, lime hydroxide, or hydrated lime. The term "hydrated lime" is the accepted trade name for slaked lime prepared by lime

manufacturers. The product is finely divided and is necessarily of high grade because in the process all unburned lumps (core) and slag or overburned lumps are rejected.

Agricultural lime.—The term "agricultural lime" was originally applied to burned or lump lime from which the unburned lumps or core and overburned lumps had not been taken out, as must be done when burned lime is offered for the building trade or chemical industries. Such lime is frequently designated run-of-kiln lime. Recently there has been a tendency to apply the term "agricultural lime" to any form of lime used for agricultural purposes, so that at present the term has no special significance.

LIME IN SOILS.

Practically all crop-producing plants require that lime in some form be present in the soils in which they grow. As a matter of fact, all soils contain some lime, and it has been assumed pretty generally that soils usually contain all the lime that is necessary for plant growth. This lime occurs in the soil in a number of different forms or combinations. In addition to the carbonate mentioned, it may be present as the sulphate, known commonly as gypsum, or as different forms of complex compounds known as silicates. These lime silicates make up a large part of some of the rocks from which soils are formed, are very slightly soluble, and furnish lime to the soil solution by slow decomposition. Lime also occurs in many soils combined with the organic constituents known as humus. In this form it usually is slightly soluble, and lime thus combined is held in the soil in a form to be utilized by microorganisms.

Carbonate of lime is much more soluble in the soil water than are the lime silicates and, when present, is leached from the soil first and lost in the drainage water. The soils of the Eastern, Southern, and portions of the Central States contain only traces of carbonate of lime, and on the basis of content of carbonate of lime the soils of the United States may be divided roughly into two geographic divisions. If a line beginning at the center of the northern boundary of Minnesota be drawn south through that State, curving west and cutting off the northwest corner of Iowa, thence west to central Nebraska, south through Kansas, Oklahoma, and Texas to near the Mexican border on the Gulf, it may be said that generally the soils east of this line, except in river bottoms and a few relatively inextensive upland areas, contain but small quantities (less than half of 1 per cent) of carbonate of lime. Such soils do not effervesce on the addition of dilute acid. West of this line the soils frequently, and the subsoils always, contain appreciable quantities of carbonate of lime, except at high elevations and on the Pacific coast.

EFFECTS OF LIMING.

If soils generally contain sufficient lime for the growth of crops, the question naturally arises, Why apply lime? The answer to this is that lime in the form either of carbonate or of oxide aids in bringing about changes in soils that make them more suitable for the growth of crops. It produces effects quite apart from supplying lime to the plant. These effects may be discussed under several heads.

Liming corrects soil acidity.—All soils contain some organic matter, the remains of previous crops or similar material that has been added to them. This organic matter decays in the soil and among the products of this decay organic acids are present. In soils in a condition of good cultivation and well drained these acids may combine with mineral constituents of the soil, their acid nature being thereby neutralized. On the other hand, they may be prevented from accumulating to an injurious extent. This latter result may be effected by drainage or by changes promoted by free access of air. When this neutralization or change does not take place and acids accumulate, the soil becomes acid, or sour. It is probable that in all cases where soils are acid because of the presence of organic acids, the soils contain excess of organic material, as in the case of mucks or peats, or the upper layer of woodland or some virgin soils. When organic acids are present in soils low in organic matter, usually there is poor drainage.

In addition to acids arising from the decay of organic matter in the soil, many soils probably contain compounds of an acid nature derived from complex silicates that form a large part of the rocks from which soils are formed. These compounds use up lime in the same way that ordinary acids do, that is, they require a certain amount of lime to be added to the soil before a neutral or alkaline reaction is brought about. Under certain conditions strong mineral acids such as sulphuric acid may be generated in soils from minerals such as pyrite, but instances where such acids have been proved to be present in quantity sufficient to bring about strongly acid conditions are not common.

Both the forms of lime used in liming have the power to neutralize acids, oxide of lime by combining directly with the acid, thereby forming a neutral, or nonacid, and usually harmless compound, and carbonate of lime by entering into a reaction with the acid whereby the carbonic-acid gas is liberated and the same neutral compound formed as when the oxide is used.

The term lime requirement is used to express the quantity of lime that must be added to a soil so that its acid character will disappear. A number of methods have been proposed for determining this, all of them requiring laboratory equipment and none of them giving any-

thing but an approximate figure. This lime requirement usually is stated in pounds of lime oxide required for an acre of soil to a depth of 6 inches or some other stated depth.

Liming improves the physical condition of heavy, compacted soils.—In heavy soils, those containing large proportions of clay or silt, there is a tendency under certain conditions for the fine soil particles to become associated so closely that the soil becomes compacted, preventing free access of air and water, a condition unfavorable to plant growth. Under other conditions the fine particles, instead of behaving in this way, tend to gather in small groups or floccules, each group behaving as a large particle. When this takes place the soil particles are said to have flocculated and the soil has a crumb structure. Every farmer knows this crumbly condition of the soil when he sees it and knows that in tilling such soils it is desirable to get the soil into that condition. Liming has been found to favor this and the consequent better aeration and drainage following the liming of heavy, compacted soils are among the important effects of liming. In some cases lime exerts a binding effect on sandy soils, preventing blowing or erosion.

Liming stimulates the proper decomposition of organic matter in the soil.—One of the advantages of an adequate supply of organic matter in a soil, or of supplying this material by means of manure, fertilizers, or cover crops, is that in decomposing it furnishes the food necessary for the growth of the bacteria that render nitrogen in the soil available to plants. In other words, it is through the decomposition of organic matter in the soil that crops can grow. A soil without organic matter or with organic matter that could not be decomposed, if that were possible, would be worthless for crop production.

Lime in the form of oxide or carbonate not only stimulates the decomposition of organic matter in the soil but brings about conditions favorable to a decomposition that will be most beneficial to growing crops.

The microorganisms that render the nitrogen of organic material available to plants and the nitrogen-fixing organisms that increase the store of nitrogen in the soil are benefited by liming. In other words, liming properly practiced tends to bring about the most economic utilization of the organic matter naturally in a soil and directs the decomposition of organic matter added to it so that its value is most fully realized.

Liming may increase the availability of other minerals in the soil.—It has been somewhat generally assumed and taught that one of the beneficial effects resulting from liming is due to the fact that applications of lime rendered other minerals, especially those con-

taining potash, more soluble and therefore available to the growing crop. Recent investigations, however, indicate that while this effect of liming may be somewhat general, it is not true to the same extent for all soils and that in some soils this effect is very slight.

Liming may furnish needed lime to plants.—As has been stated, the assumption is general that all soils contain sufficient lime to satisfy the needs of the plant for lime in building up its tissues. There is, however, considerable evidence indicating that this may not always be the case and some of the beneficial results following liming may be due to the direct furnishing of needed lime to the plant. Soils are not uncommon in which the content of lime in any form is less than the content of any other common element, and it is not unreasonable to suppose that in growing on such soils crops like clover or alfalfa, crops that are known to take large quantities of lime from the soil, the benefits from liming may be due, in part at least, to the direct supply of lime.

General discussion of the effects of liming.—Of the several effects of liming just mentioned, the correction of soil acidity is probably the one most commonly thought or spoken of, the others being considered secondary. Consideration, however, of the relative weights of these effects of liming will lead to the conclusion that the correction of acidity is not the most important. Although there are large areas of uncultivated soil that are decidedly acid, they are for the most part areas that are in need of drainage and are acid for that reason. Soils that are decidedly acid are not nearly so common in cultivation as is somewhat generally supposed. Peats and muck soil, where not associated with marl deposits, are often decidedly acid, and soils of all textures where drainage conditions are bad also may be decidedly acid, but the great majority of soils that are almost devoid of carbonate of lime and that respond in crop yields to liming are not strongly acid when judged by any standard in use for that purpose.

As has been stated, the presence of decomposable organic matter is essential to a fertile soil, and organic matter is added to soils in the form of fertilizers, manure, and cover crops for the purpose of being decomposed, and no fact is more clearly demonstrated in connection with liming than that the addition of lime to a soil promotes this decomposition or tends to direct it in a way that is favorable to the growth of crop plants. This is an effect that takes place in all soils, and it would seem therefore that because this effect of liming is the most general it is the most important.

The effect of liming on the physical condition of the soil is observable where the physical condition is in need of improvement, that is, it is one that will be observed chiefly on heavy, compacted soils.

The effect of lime in liberating other minerals in the soil and of supplying needed lime to the plant are effects that apparently are limited also in their operation to certain types of soil.

The relative importance of the different effects of liming may be stated as follows: The effect on the decomposition of organic matter in the soil is most general and probably of first importance. The correction of soil acidity comes next in importance, and this importance will increase in proportion to the increase in acreage of sour or acid soils under cultivation. The effect of liming on the physical condition of the soil may be considered perhaps of somewhat less importance than the correction of soil acidity. The effect of lime in liberating other minerals and of supplying lime direct to the plant may be considered of minor importance, although there may be cases where these effects are of first importance.

It is evident that several or all of the effects of liming may operate in the same soil at the same time, and it is likely that in few cases are the benefits resulting from liming due to one effect alone.

FARM PRACTICE OF LIMING.

In attempting to increase his crop yields by liming the farmer naturally seeks to accomplish this with the least expense for labor and material, and he also should keep in mind the necessity of maintaining or increasing the fertility of his soil for future crops.

The factors to be considered in the practice of liming may be discussed under several heads.

THE SOIL.

The soil, either as nature made it or as modified by previous cultivation, for purposes of immediate utilization, the farmer must take as he finds it.

As was brought out in the discussion of the effects of liming, all soils that need lime do not need it for the same reason. As the result of liming, one soil may be benefited chiefly through the neutralization of its acidity and another through the improvement of its physical condition, but in nearly all soils the decomposition of the organic matter will be hastened and in some cases all effects will operate at the same time.

The kind of soil and the result sought to be accomplished will determine in part the practice to be followed. Peats, muck soils, and nearly all soils devoid of carbonate of lime and having poor drainage are likely to be decidedly acid, and the liming of these should be practiced with a view to remedying that condition. This practice frequently will call for a large application of lime.

A heavy soil that has become compacted so that drainage and circulation of air are hindered should be limed for the correction of that condition and for that purpose comparatively smaller applications will be effective if the soil is not at the same time acid. It may be that the topsoil is in fairly good physical condition but that the drainage is bad because of the presence of a hardpan or impervious layer at lower depths. Surface applications of lime, which tend to modify the character of the topsoil only, will remedy such conditions very slowly, if at all. In some such cases merely breaking through the impervious layer will be sufficient, but in others drainage must be provided by the usual means of ditching or tiling.

In stimulating the decomposition of organic matter it may be assumed that any application of lime, however small, will be of service in this direction; but here there comes into consideration one of the most important points in connection with liming. The organic matter in a soil is of service chiefly because it decomposes, and lime aids in decomposing it; but many light sandy soils contain very little organic matter, and to stimulate the decomposition of this without taking steps to replace, or if possible to increase the supply by applications of manure or plowing in green crops would be disastrous for future crops.

One of the first rules to be observed in liming is that lime in any form should not be applied to soils deficient in organic matter, especially in warm humid climates, without taking steps to put organic matter into the soil to keep up, or if possible increase, the supply of this essential ingredient.

THE CROP.

In considering the crop in its relation to liming it must be borne in mind that, except for some general relations true for a particular crop on almost all soils, the nature of the soil will determine whether or not a particular crop requires that lime should be added to the soil for best production.

Of first consideration in this connection is the fact that leguminous plants usually require a plentiful supply of lime; or, in other words, it is generally true that legumes take large quantities of lime from the soil. Further, many legumes are sensitive to acid soil conditions and do not grow well or frequently not at all where such acid conditions exist. This is particularly true of alfalfa and red clover and perhaps to a less degree of sweet clover and vetch. On the other hand, cowpeas and soy beans usually do not respond to liming, and white clover grows well on acid soils.

Corn is usually considered to be tolerant of acid conditions and such grasses as redtop, Bermuda grass, and lespedeza grow well on acid soils. Bog plants, such as blueberries and cranberries, require

an acid soil and such fruits as strawberries and raspberries apparently are not benefited by applications of lime.

The great majority of garden and truck crops and cereals usually are benefited by liming, but when it is recognized that different soils require lime frequently for different reasons, one for correction of acidity, another for improvement of the drainage or to supply lack of lime, it is clear that a crop that responds to liming on one soil may not do so on another. This leads to the advice that farmers should experiment with their own soils to determine the response to liming with different crops. This advice applies also to fertilizer practice, crop rotation, varieties grown, and in fact to all the operations connected with the growing of crops, and only when farmers do this and make use of the information so gained can the best results be expected.

USE OF LIMING MATERIALS.

Under the heading "materials" it has been stated that the material used in liming is either carbonate of lime or oxide of lime, and that there are several kinds of these two forms. It sometimes happens that because of local market or other conditions a farmer is limited to one form of lime—that is, because of the expense of freight, etc., other forms are prohibitive in cost—but usually the farmer has a choice of several kinds or brands.

Where this is the case the choice may be said to be first between carbonate of lime and the oxide, and this makes necessary some discussion of the way these two forms of lime behave in the soil.

CARBONATE OF LIME.

Carbonate of lime is almost insoluble in pure water, but water holding carbonic-acid gas in solution, as does all soil moisture, dissolves appreciable quantities, depending on the quantity of carbonic-acid gas in solution. It is due to this solubility in the soil solution that carbonate of lime in the form of limestone is gradually leached from soils.

If the soil water contains a free acid in solution, as may be the case in some instances, this acid might be neutralized by the soil solution coming in contact with solid particles of carbonate of lime, an effect that might be produced without the carbonate of lime being previously dissolved. Probably, however, in most cases acids or acid compounds in soils are so slightly soluble that they are neutralized by the carbonate of lime in solution coming in contact with the more difficultly soluble acid.

Regarding the action of carbonate of lime in stimulating the decomposition of organic matter, only the general principles involved are known or understood. It is known that the growth of many

microorganisms active in decomposing the organic matter of soils is hindered by an accumulation of free acid, therefore the stimulation of the decomposition in many cases doubtless is due indirectly to the neutralization of acid, making the soil thereby more favorable for the growth of microorganisms. On the other hand, however, many forms of decomposition may advance to a considerable degree under acid conditions. In other cases the favorable action may be due simply to the fact that the new compounds formed by the combination of lime with neutral organic compounds are in a form available for plants or microorganisms.

The effects of lime in flocculating soil particles and making the conditions more favorable for the circulation of air and water, as well as the effect of making soluble other minerals, so far as they are understood, depend on the lime being in solution in the soil moisture.

Except, then, for cases such as the neutralization of an acid in solution by coming in contact with solid particles of carbonate of lime, the beneficial effects of carbonate of lime when added to a soil follow only after this lime has gone into solution in the soil moisture. This being the case, the value of any carbonate of lime, so far as its chemical activity in the soil is concerned, depends on its content of carbonate and on its solubility.

The rapidity with which any material not readily soluble in water is dissolved depends on how finely it is powdered or pulverized—that is, on how much surface is exposed to the action of the water. This is true of carbonate of lime; and though there may be slight differences in solubility due to kind of material and the nature of impurities present, for all practical purposes the rate of solution of one kind of carbonate of lime may be assumed to be the same as that of any other kind of the same degree of fineness.

In addition to its effect on rate of solution fineness of grinding of carbonate of lime makes it possible for the material to be more thoroughly distributed throughout the soil so that the solution formed comes in contact with all of the soil in a shorter time.

The value of carbonate of lime, therefore, so far as its immediate activity in the soil is concerned, is dependent on the extent to which it is powdered or pulverized, for it is only through solution that the lime can be distributed and reach all parts of the soil.

OXIDE OF LIME.

In discussing oxide of lime it was pointed out that any form of carbonate would furnish the oxide on burning. The oxide may differ somewhat according to the material from which it was made and may differ as to preparation, whether lump or ground, and whether slaked (hydrated) or unslaked. Some consideration must be given, then, in this connection as in the case of carbonate, to the way in which the oxide behaves in the soil.

Calcium oxide or oxide of lime has a great affinity for water. When it is brought in contact with water chemical action takes place, heat is generated, and the lump of lime falls to a dry powder or forms a semifluid milky mass, according to the quantity of water used.

In this reaction (slaking) chemical combination between this oxide and the water takes place. The same action takes place, but more slowly, when the oxide is exposed for a time to the air, simply by the moisture of the air being taken up, but in this case the process is extended over so long a period of time that the heat generated is not noticeable. This process, called air slaking, takes place even in fairly tight containers, such as barrels.

The oxide of lime after slaking is in the form known as calcium or lime hydroxide, and usually when oxide of lime is used in agriculture it is slaked and changed to the hydroxide form before applying to the land; if not, this change very soon takes place by combination with the moisture of the soil.

Lime hydroxide is many times more soluble in pure water than is carbonate of lime, or even than carbonate of lime is in water charged with carbonic-acid gas as soil moisture is. The first result, then, when the hydroxide comes in contact with water is solution. When lime hydroxide is applied to a moist soil solution also takes place and this solution tends to be diffused throughout the soil. Theoretically the fate of this calcium hydroxide in solution in the soil moisture would be its conversion into calcium carbonate through interaction with the carbonic acid also held in solution. The extent to which this reaction would go would depend on the relative proportions of the two reacting compounds present. If much calcium carbonate were formed in this way it would be thrown out of solution and finally react in the soil in the same way as finely divided carbonate added to the soil directly.

In some cases, no doubt, there is direct union of the lime hydroxide with organic compounds without the previous formation of carbonate, but in a general way the chemical processes by which beneficial effects on crops are produced must be the same whether the oxide or carbonate be used.

There are two conditions in which the use of lime oxide may bring about somewhat different results from those produced by the carbonate. If the oxide, either ground or in lump form, should be applied to the soil without first slaking, contact with moist soil would at once bring this slaking about, considerable heat would be generated and chemical changes brought about in the soil at points where the slaking took place might be quite different from those following applications of lime already slaked.

It is due chiefly to the generation of heat and abstraction of water accompanying slaking that the popular idea regarding the caustic or

burning character of burned or quicklime is due. As a matter of fact, after slaking has taken place and normal temperature been reached, the resulting hydroxide is at ordinary temperatures very mild in its chemical activity and harmless in its relation to organic material.

Another condition where lime hydroxide might behave in a manner different from the carbonate is met with in the case of light sandy soils containing little organic matter. Here the amount of carbonic-acid gas in the soil water is apt to be small and the water-holding power of such soil is low. In consequence, if slaked lime had been added, the hydroxide would not be changed rapidly into carbonate or in the absence of organic matter and finely divided mineral matter little opportunity would be offered for other chemical combination and there might be a rather free circulation of a saturated solution of lime hydroxide in the soil. This would result in much of the lime being leached away in place of being changed to carbonate and held in the soil to bring about the slow changes and beneficial results desired. In addition the saturated solution of lime hydroxide has some dissolving action on organic constituents, and this might result in a loss of the already deficient organic matter by solution and leaching.

It was pointed out in connection with carbonate of lime that the relative values of different forms depend on the content of carbonate and the fineness of the particles. A similar statement holds for lime oxide, but as a matter of fact all forms when slaked are extremely fine and probably of equal value in that respect, so that the value of different forms of lime oxide depends on their purity or content of lime oxide.

The farmer has, then, in the choice of material, the following facts to consider, so far as the efficiency of lime in the soil is concerned. All forms of ground or pulverized carbonate of lime are approximately alike if their purity is the same and they are ground to the same degree of fineness. If of the same purity their efficiency depends on the fineness of grinding, the finer being the more active; and vice versa, if of the same fineness, their efficiency will be in proportion to the content of carbonate of lime, or carbonate of lime and magnesia where magnesian limestone is used.

In the case of burned lime all forms when slaked are approximately of the same degree of fineness and their value depends on the purity or content of oxide of lime or lime and magnesia.

LIME OXIDE VERSUS LIME CARBONATE.

It has been pointed out that the value of lime oxide represented by burned lime depends upon its purity, and that for immediate effect the value of carbonate of lime represented by ground or pulverized limestone depends upon its purity and the fineness of grinding. It is plain, then, so far as immediate efficiency in the soil is concerned,

that the value of the latter, as compared to the former, depends on the equivalent value of carbonate when calculated to oxide and how nearly its fineness approaches the fineness of slaked lime; in other words, What is the equivalent lime oxide calculated from the lime carbonate, and how much fine material that may be considered immediately available is there in the pulverized limestone?

The relative value of lime carbonate to oxide of lime is in the ratio of 56 to 100; or, in other words, 100 pounds of carbonate will produce 56 pounds of oxide on burning. Stated in still another way, 100 pounds of carbonate must be used to produce the same chemical effect as 56 pounds of oxide.

It is not possible within the limits of reasonable cost to grind limestone so that it is all as fine or even nearly as fine as slaked lime, and this has led to proposed standards or specifications regarding this feature.

In general terms it may be stated that the finer limestone or similar material is ground the more it will cost, and the finer it is ground the more quickly soluble and effective it will be in the soil. Naturally, however, there is a point where added expense for fine grinding is not warranted, because the increased crop production does not offset the increased cost of material. Results from field tests regarding the efficiency of limestone of different degrees of fineness, while naturally varying considerably as influenced by differences in soil, crop, and climate, all agree in support of the contention that some degree of fineness is necessary for immediate effect.

It may safely be assumed, therefore, that in the case of ground or pulverized limestone it is only the material of certain fineness that is immediately available and is comparable in value with the fine material obtained on slaking burned lime, and for immediate results fine material is all that should be considered in computing the relative values of such products.

Coarse material, though not immediately available, naturally is of some value, is slowly dissolved, and has its effect on the soil; but this naturally varies with varying conditions.

Though suggestions and ideas regarding the degree of fineness that should be required in pulverized limestone differ somewhat, probably a specification that a large percentage shall pass a 60-mesh sieve is the one most frequently made, and probably comes near striking the medium between very fine material at very high cost and coarse material produced cheaply.

As an example of how the comparative values of different materials may be calculated by means of this standard, a case may be assumed. Suppose that laboratory examination or experience with a similar soil indicates that a soil requires the immediate effect of 1,000 pounds

of oxide of lime or the equivalent quantity of the carbonate. Suppose, further, that the farmer is offered the following: Burned lime, 90 per cent oxide of lime, at $7.50 per ton; coarsely ground limestone, 85 per cent carbonate, 20 per cent passing a 60-mesh sieve, at $1.50 per ton; finely ground limestone, 85 per cent carbonate, 80 per cent passing a 60-mesh sieve, at $3.50 per ton. What are the relative values of these for immediate effect? Using the data given, the following result is obtained:

To furnish 1,000 pounds of oxide of lime would require 1,111 pounds of the burned lime, costing	$4.16
To furnish the equivalent of 1,000 pounds of oxide of line in the form of carbonate of lime would require 10,500 pounds of the coarsely ground limestone with 20 per cent passing a 60-mesh sieve, costing	7.87
To furnish the equivalent of 1,000 pounds of oxide of lime in the form of carbonate of lime would require 2,610 pounds of finely ground limestone, with 80 per cent passing a 60-mesh sieve, costing	4.56

In addition to the differences thus disclosed, it must further be noted that ten times as much coarsely ground limestone or two and a half times as much finely ground limestone is required, the freight and haulage of which must be considered. It should be noted in this connection that the prices quoted while in the proportion current in some localities are not suggested as proper values for such material but are assumed for the purpose of this calculation only. It should further be noted that this calculation is based on the assumption that in the case of ground limestone only material passing a 60-mesh sieve is immediately effective, and that immediate effect only is considered. The coarser material not considered in this calculation has some value for future crops.

In actual practice it is not possible to calculate relative values so closely as illustrated. In the first place, it is not possible to determine the needs of any particular soil for immediate lime effect more than approximately; the relative efficiency of carbonate of lime of different degrees of fineness necessarily varies with soil and climate, and generally the farmer does not know the composition of the material he uses, or at most only approximately.

The following facts should, however, be borne in mind in this connection: It requires approximately twice as much carbonate of lime to bring about the same chemical effect as oxide. A considerable portion of fine material in the ground or pulverized carbonate (limestone) is necessary for it to be immediately effective. If, then, a brand of ground limestone contains a fairly large percentage of fine material and contains 85 per cent or more of carbonate, it is probably worth half as much per ton as a high grade of burned lime and no more. Twice as much, however, must be used, and freight and haulage on the excess quantity must be considered in computing the cost.

Comparative tests of burned lime and ground limestone have been made at many of the agricultural experiment stations on a variety of crops, and while in some cases burned lime has been found to give the greater yield and in other cases the ground limestone, the general opinion is in agreement with that expressed in a bulletin from the Ohio Experiment Station: "In actual practice the experiments made by the Ohio Experiment Station have shown no practical superiority of one form of lime over the other provided the limestone has been so ground that 80 per cent of it will pass through a sieve having 100 meshes to the linear inch and provided of course that the two materials have been used on the basis of the actual calcium contained."

In the following table is shown the oxide-of-lime value of grades of carbonate (limestone) from 95 to 70 per cent and the oxide value of the material that will pass a 60-mesh sieve in the same grades:

Oxide-of-lime value of different grades of carbonate (limestone).

Carbonate of lime.	Total oxide of lime per ton.	Oxide of lime per ton where—			
		20 per cent passes 60-mesh sieve.	40 per cent passes 60-mesh sieve.	60 per cent passes 60-mesh sieve.	80 per cent passes 60-mesh sieve.
Per cent.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
95	1,064	213	425	638	851
90	1,008	202	403	605	806
85	952	190	391	571	761
80	896	179	358	538	716
75	840	168	336	504	672
70	784	157	313	470	627

Hydrated lime carries with it the water that has combined with the oxide, and consequently its oxide value is less than that of quicklime. The relation between the two is such that 100 pounds of hydrated lime contains approximately 75.7 pounds of oxide, and the relation between the three is as follows: 100 pounds of carbonate (limestone) are equal to 74 pounds of hydrate (slaked lime) or 56 pounds of oxide (burned lime); or, to put it in general terms, two parts of oxide are equal to three of hydrate or four of carbonate.

Under the discussion of materials mention was made of magnesian limestone, which is a mixture of lime and magnesia carbonates in varying proportions. Limestone of this kind and lime made from it by burning are somewhat generally offered for sale and used for agricultural purposes. This form of limestone does not react as readily with acids as does the ordinary—does not effervesce with a dilute acid at ordinary temperatures. The lime made from it does not slake as readily as that made from ordinary limestone, and probably acts more slowly in the soil.

In the past opinions differed considerably regarding the value of magnesian limestone or the lime made from it for agricultural pur-

poses, but the general opinion now seems to be that they are equal in value to the limestone or lime from ordinary limestone if of the same purity and degree of fineness.

The relation of magnesia carbonate to magnesia oxide is slightly different from that between lime carbonate and lime oxide, but the difference is so small that for all practical purposes the value of a magnesian limestone can be judged by its content of the two carbonates and a lime by its content of the two oxides. While 100 pounds of lime carbonate will yield 56 pounds of lime oxide, 100 pounds of magnesia carbonate will yield only 48 pounds of magnesia oxide, and 100 pounds of a mixture of equal parts of magnesium and calcium carbonates will yield 52 pounds of the two oxides. This fact gives ground magnesian limestone or the lime made from it a slightly greater neutralizing power than have the ordinary calcium limestone or lime.

OTHER FORMS OF LIME.

Other lime compounds than those discussed here are sometimes added to soils either directly or as components of fertilizers or other material.

Land plaster.—Land plaster, known also as gypsum, calcium sulphate, or sulphate of lime, has been somewhat extensively used in agriculture.

This lime compound is not active in any way in neutralizing soil acidity, and while it may bring about any of the other effects of liming, its action which frequently is referred to as a stimulating one is generally believed to be of benefit chiefly through the liberation of potash from soil minerals. Land plaster is also of value as an addition to manure and composts because it prevents the escape of ammonia from such material.

Acid phosphate.—Acid phosphate, also known as superphosphate, prepared by treating rock phosphate with sulphuric acid, contains both acid phosphate of lime and sulphate of lime. Acid phosphate is used both alone and as an ingredient of mixed fertilizers. For every 1 per cent of phosphoric acid in such material there is approximately 2 per cent of sulphate of lime and one-third of 1 per cent oxide of lime combined with phosphoric acid. Some of the effects of acid phosphate may be due in certain cases to the lime thus furnished, although this form has no power to neutralize soil acid conditions.

Ashes.—The ashes remaining after burning wood contain the mineral elements that were in the wood in the form of oxides or carbonates. Potassium carbonate and calcium carbonate or oxide are present in considerable and frequently large quantities and the ashes have a strong alkaline reaction, with the power to neutralize soil acidity in proportion to their content of oxides or carbonates.

The commercial value of wood ashes usually depends more on their content of potash than of lime, but nearly all contain enough lime to warrant their being considered among liming minerals.

Compost and manure.—All vegetable and animal material contains some lime, usually in combination with organic material or acids, and when it is added to soils this lime goes to replenish the store of lime in the soil. Lime from such sources is not effective in correcting soil acidity or improving the physical conditions of a soil.

Basic slag.—Basic slag, known also as Thomas slag, is a by-product of the iron industry and is used as a fertilizer. It is a phosphate of lime with an excess of lime. It has an alkaline reaction and when used on an acid soil tends to bring about a neutralization of

FIG. 2.—Burned lime on the field to be spread after slaking.

acid conditions to the extent of the excess of lime in it. Usually, however, it is not used in sufficient quantity to bring this about to more than a very limited degree.

OTHER FACTORS IN LIMING.

Time and method of application.—To a large extent the time and method of application are fixed by the kind of material, the nature of the soil and crop, and the farmer's convenience. So far as any possible injury is concerned, carbonate of lime in any of the several forms may be applied at any time. This material produces no injurious effect by direct contact with seeds or young plants, and does not tend to set ammonia free from stable manure.

Carbonate of lime should, however, not be mixed with or applied at the same time with acid phosphate, since such mixture or applica-

tion tends to bring about a change of the water-soluble phosphoric acid to an insoluble form, and any advantage in buying the more expensive acid phosphate is lost.

In considering the time of application of carbonate of lime, it must be remembered that it is slower in its action than burned lime, especially if not finely ground.

Oxide of lime, either in the form of burned lime or hydrated lime, requires somewhat more care in regard to time of application. It should not, especially if the unslaked form be used, be applied to the land so that it comes in contact with seeds or young plants. Like the carbonate, it should not be mixed with acid phosphate or applied at the same time, and should not be mixed with stable manure.

Lime may be applied by drilling with a seed drill or spreading with a lime spreader. (See title page.) Drilling is frequently not a satisfactory method, because the material may not be suited to proper distribution in this way and uniform distribution throughout the soil is not accomplished. Various types of lime spreaders are on the market and it is often possible for the farmer to devise home-manufactured machines for this purpose that are satisfactory. Spreaders may be used for ground limestone, hydrated lime, or burned lime after slaking. The practice of placing burned lime in piles in the field and slaking it by the addition of water or allowing it to slake in the air and then spreading by hand is a somewhat common one. Apart from the disagreeable features of this method the objections to it are that uniform distribution is difficult to accomplish and the slaking in a pile sometimes has an injurious effect on the soil immediately beneath the pile.

Whether lime should be applied before plowing or after plowing, and then harrowed in, as well as the time and manner of applying to growing crops where that can be done, are matters that must be decided in each individual case according to conditions and results sought to be accomplished. Probably application after plowing, followed by harrowing, is the most general and satisfactory practice. One important point in connection with the application of lime is the desirability of having the lime as thoroughly and uniformly distributed through the soil as possible.

Quantity.—The quantity to be applied naturally depends on the needs of the soil, on the form of lime used, the climatic conditions, and time of application. Applications of burned lime are usually from one-half a ton upward, or the equivalent, of carbonate of lime, although beneficial results frequently may be obtained by the use of smaller quantities. The conditions that make liming necessary, when corrected, tend to recur again after a time, the length of which depends on the soil and the treatment it receives. This makes it necessary to repeat the liming from time to time.

The question whether a large application once in several years is preferable to smaller applications more frequently, is one regarding which no general rule can be made. Arguments can be presented in favor of each procedure, and it is a matter where experiment and experience must decide.

Loss by leaching.—The leaching of lime from a soil, resulting in loss of valuable material, is a matter that should receive consideration in the practice of liming. It has been stated that the finer a lime is pulverized the more effective it is or the more immediately does it react in the soil. This effectiveness depends on ready solubility and if very fine material be applied in excess of that which can be held in the soil in a difficult soluble form it will be leached from the soil and lost.

This loss by leaching is a factor operating particularly in light soils having little organic matter and where the drainage is apt to be excessive, and is especially large in the South where such soils predominate and where the mild climate and heavy rainfall bring about leaching throughout the year.

Green manure.—It is evident from statements already made that the practice of liming, carried on as it should be, stands in very close relation to that of growing green crops to be plowed in to furnish organic material to the soil, and while good results frequently follow the plowing in of green crops where no liming is practiced usually the benefit will be still greater if lime is applied to the soil.

Few farms produce enough manure to maintain the organic content of all the land at the point where it should be. The use of commercial fertilizers containing organic matter such as dried blood, tankage, or cottonseed meal contribute but small quantities of this material, so that the plowing in of green crops is the only other method of accomplishing this result.

Leguminous crops such as clovers and cowpeas are usually grown for this purpose, although nonlegumes such as rye are sometimes used. To grow clovers successfully the majority of soils must be limed.

SOIL ACIDITY.

Soil conditions that make liming desirable or necessary are in many cases matters of ordinary observation or experience, but the reasons for the demand of the soil for lime are frequently not apparent. This is particularly the case with regard to the reaction of the soil, whether or not it is acid.

Though it may be assumed that a soil high in organic matter is acid, and certain types of native vegetation indicate acid conditions, the great majority of cultivated soils that may be slightly acid do not indicate that fact in any way that is conclusive to the farmer.

Indicators of soil acidity.—Soils that contain large quantities of organic matter, such as peats or muck soils, if not intimately asso-

ciated with marl deposits, are usually acid; and practically all soils, even when the content of organic matter is low, are acid if the drainage is poor.

The character of the native forest or other vegetation often indicates an acid soil. Among such indicators may be mentioned the growth of blueberry and wintergreen bushes, the presence of chestnut or sassafras trees, or a scrubby growth of oak or jack pine. In cultivated fields the presence of weeds such as sorrel or growth of moss on the surface of the soil may indicate acidity, but generally in the case of cultivated soils that may be slightly acid some test must be applied to the soil.

Lime requirement.—Mention has been made of laboratory methods for determining the lime requirement of soils, and in this connection it should be remembered that lime requirement and acidity are not necessarily the same. In other words, a soil may have a high lime requirement and still not be strongly acid as judged by other tests. The lime requirement being the quantity of lime necessary to add to the soil to bring about an alkaline reaction, this high lime requirement in the absence of high acidity probably is due to what may be called the absorptive power of the soil for lime.

Not infrequently the lime requirement as obtained by a laboratory method is not in actual accord with the field experience, and it is safe to assume that the real test of the reliability of any laboratory method of determining lime requirement is whether or not it gives a requirement in fair agreement with actual farm practice.

A laboratory examination will frequently indicate whether or not it is advisable to use lime at all, and, in any case, it gives whatever information is obtainable much more quickly than a field test, but it can not be too strongly urged upon farmers that they should experiment with their own soil in the field.

A number of methods have been proposed for determining whether or not a soil is acid that do not require laboratory equipment or special training, but it does not appear that any of them is generally applicable to all conditions or gives reliable results, with the exception of the litmus-paper test.

The litmus-paper test.—Certain dyes have the property of changing color when brought in contact with acids or alkalies. Such dyes are known as indicators, and litmus is one commonly used in this way. Litmus when in contact with moisture and an alkali such as lime hydroxide turns blue; and if to the blue litmus thus formed a slight excess of acid be added over that required to combine with and neutralize the lime, the litmus turns red. Between the blue and red is a neutral point, a light purple shade.

Litmus paper is an absorbent paper saturated with red, blue, or neutral litmus, and this when properly prepared is sensitive to slight acidity or alkalinity—that is, blue litmus when moistened

will turn red on contact with an acid, and vice versa red litmus will turn blue on contact with an alkali, indicating on the one hand what is called an acid reaction and on the other an alkaline reaction.

Litmus paper is used in testing soils for acidity; and the test usually is made by moistening the soil to form a compact mud, making an opening in this, inserting a strip of blue litmus paper, closing the soil around it and allowing it to stand for a short time and then noting any change of color. Precaution should be taken to prevent contact of the moist litmus paper with the fingers.

A modification of this method of making the litmus-paper test that has some advantage, especially in the case of red-colored soils, is

FIG. 3.—Valuable deposits of marl are found in many parts of the country and are convenient sources of lime.

as follows: The moistened strip of litmus paper is placed on the side or bottom of a glass or beaker and the dry soil then introduced into the glass, moistened thoroughly, and allowed to stand. Any change of color of the litmus paper can be observed through the glass and contamination of the paper with soil particles is prevented.

The interpretation of the change of color, if such occurs, is to some extent a matter of personal judgment and is most reliable when used by one of experience. The following points should be observed in using this test, and in drawing conclusions from it:

If the soil is dry it should be moistened and allowed to stand for a time before the test is applied.

If the soil effervesces on the application of dilute muriatic acid it probably contains more than half of 1 per cent of lime carbonate

and does not need liming, although it may show no alkaline reaction with red litmus. Frequently soils that do not effervesce are not in need of lime.

A mere bleaching of the blue color or leaching out by soil moisture should not be mistaken for a change to red. To prevent this as far as possible no more water should be used than is necessary to moisten the soil thoroughly.

Care should be taken that a mere staining of the surface of the paper by adhering grains of a red or reddish colored soil is not mistaken for a change of color of the paper.

The litmus-paper test, except in extreme cases, will not show difference in soil acidity.

FIG. 4.—Making a lime kiln on a West Virginia farm.

A great many soils that do not show a strongly acid reaction with litmus paper have a high lime requirement, that is, they require an application of a considerable quantity of lime before they will show an alkaline reaction with red litmus paper and also respond in crop yield to liming.

LOCAL GRINDING OR BURNING.

If deposits of limestone are found on or near the farms on which it is desired to practice liming, the question of the desirability or profit of grinding or burning such material locally with farm labor presents itself.

In considering this matter it should be remembered that in the case of ground or pulverized limestone or of burned lime, the interest on the value of a limestone deposit is but a small part of the cost of such material when placed on the market. The chief items of cost of such material are labor, depreciation, the running of machinery or equipment, and fuel, and the chief advantage in having such a deposit near at hand is in the saving of freight and haulage.

It may be taken for granted that any farmer or community of farmers in attempting to use a local limestone supply will not turn out a product as efficiently as will a manufacturer with larger equipment and experience in the business, and that therefore the project

FIG. 5.—The kiln burning.

should receive careful consideration before undertaking. The ability to obtain material when wanted and the fact that the utilization of a local limestone deposit will render the farmers in the vicinity independent of freight congestion or other factors contributary to unsatisfactory delivery of liming material make the utilization of local limestone deposits a thing to be recommended in many localities. This is particularly true when local fuel is also available.

It should be pointed out in this connection, however, that portable crushers frequently do not grind as fine as is desirable, and such machines frequently deteriorate rather rapidly. Furthermore, prospective purchasers of portable crushers should not be satisfied with a

demonstration unless assured that the limestone with which the demonstration was made is as hard as that they propose to grind.

It is not likely that local lime burning can be profitably conducted by farmers except where a local fuel supply is available, and the general statements made regarding local grinding apply also to local lime burning.

In the case of both local grinding and crushing, limestone of lower grade can be made use of than could be used for the production of liming material commercially.

Where local marl deposits are available such material can be used profitably provided the cost of excavating or placing on the land is not too great.

In the utilization of local limestone or marl no expense should be incurred for machinery or equipment without first having the material it is proposed to use analyzed or examined by one competent to judge of its value for agricultural purposes.

WHAT SHOULD NOT BE EXPECTED OF LIMING.

Liming will not take the place of drainage. Acid-soil conditions frequently are due to poor drainage, but liming can improve only the conditions in the upper soil, making for better circulation of air and water. Impervious layers or hardpan should be broken up.

Liming can not take the place of proper crop rotation, cultivation, or soil management. In fact, the use of lime makes it more necessary that rotation and all cultural methods be studied more carefully.

Lime does not supply any of the elements furnished by fertilizers—potash, phosphoric acid, or nitrogen. The use of lime may enable the farmer to do with less fertilizer, or in an emergency to do without it altogether for a time.

Good results should not be expected from the application of lime to a soil deficient in organic matter, and liming should not be expected to build up such a soil unless such organic matter is supplied either in manure or green crops plowed in.

TERMS USED IN LIMING.

The following terms are used commonly in discussing the agricultural use of lime. The majority of these have appeared and been defined in the foregoing text, but for convenience are repeated here.

Weight of lime.—A Federal statute provides that in interstate shipment a large barrel of lime shall consist of 280 pounds and a small barrel 180 pounds net weight. The weight of a bushel of lime is fixed by law in several States and varies from 72 to 80 pounds.

Reaction.—A term applied to the behavior of a solution or a solid, when moist, when brought in contact with certain dyes called indicators. A solution or solid when moist that turns blue litmus red is said to have an acid reaction, and one

that turns red litmus blue an alkaline reaction. Slaked lime, or lime hydroxide, has an alkaline reaction.

Lime requirement.—The quantity of lime necessary to be added to a soil to produce a slight alkaline reaction. It is usually stated in pounds of lime per acre to the depth of 6 inches or other depth.

Fat or rich lime.—Sometimes called hot lime. Is lime made from limestone containing less than 10 per cent of impurities. On slaking it usually generates considerable heat.

Lean or poor lime.—Is made from limestone containing more than 10 per cent of impurities. It usually slakes slowly. Limestones ground for agricultural use frequently yield poor or lean lime on burning. The terms in this and the immediately preceding paragraph are used commonly in the building trade.

Magnesian or dolomitic lime.—Lime made from a limestone containing 10 to 15 per cent or more of magnesium carbonate.

Hydrated lime.—Trade name for slaked lime, or lime hydroxide, prepared by manufacture.

Carbonate of lime.—Lime oxide combined with carbonic acid. It occurs naturally as limestone, marl, oyster shell, coral, etc.

Oxide of lime.—Formed from carbonate by burning, whereby the carbonic acid is driven off. It does not occur in nature. It is known in trade as burned lime, quicklime, stone lime, caustic lime, or builder's lime.

Hydroxide of lime.—A combination of oxide of lime with water. It is also known as slaked lime or hydrated lime.

Agricultural lime.—A term originally applied to burned lime prepared for agricultural use, but now somewhat commonly applied to any form of lime intended for use in liming.

Liming.—The application of lime either in the form of carbonate or oxide to the soil.

Lime-oxide equivalent.—The proportion of oxide of lime in the carbonate or hydroxide. For pure material the ratio is approximately two parts of oxide (burned lime) are equal to three parts of hydroxide (slaked lime) or four parts of carbonate.

Sieves.—In grading ground or pulverized limestone or similar products, sieves of different-sized mesh or openings are used to separate the material into proportions of different grades of fineness. A 10-mesh sieve has 10 meshes to the running inch, or 100 meshes per square inch. A 60-mesh sieve has 3,600 meshes per square inch.

Organic matter.—Animal or vegetable material that has been left in or added to a soil. It includes material in all stages of decomposition from comparatively fresh material, the origin of which can be determined, to that thoroughly decomposed and in part, at least, combined with the mineral constituents of the soil.

Humus.—A term applied to the more or less dark colored, thoroughly decomposed organic material in a soil. It is known to be made up of a great variety of organic compounds, and the coloring material is frequently but a small part of the total humus.

Green manure.—A term applied to any crop grown for the purpose of being plowed in to replenish the supply of organic matter. Leguminous crops, such as the clovers and cowpeas, are grown most frequently for this purpose, but others, such as rye, are sometimes used.

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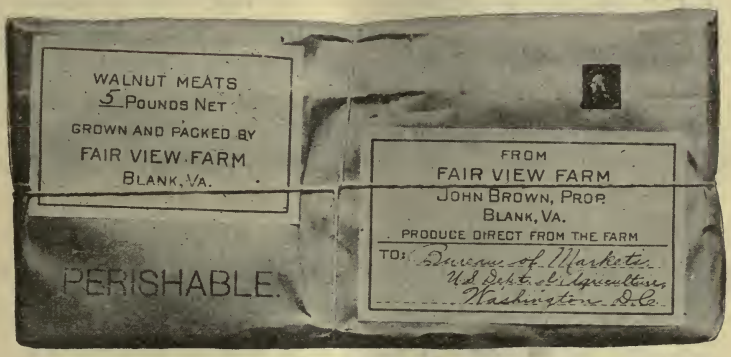
PARCEL POST BUSINESS METHODS

C. C. HAWBAKER and JOHN W. LAW

Assistants in Marketing by Parcel Post



FARMERS' BULLETIN 922

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Markets

CHARLES J. BRAND, Chief

Washington, D. C. February, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

HOUSEWIVES appreciate receiving farm produce which they know to be fresh. Many farmers within 150 miles of cities have regular supplies of high-grade produce, the quality of which they can guarantee. The parcel post offers a means of direct dealing between producer and consumer, with profit to both.

Parcel-post shipments are increasing in number, though probably they always will affect only a small percentage of the farm produce that goes to market. Dealing by parcel post succeeds if the farmer is careful to keep up the quality of his produce, packs it safely and attractively, and meets his engagements promptly—always supposing that the consumer also observes business methods in the transaction.

This bulletin gives detailed suggestions regarding means of obtaining customers and methods of carrying on business, with samples of suitable letterheads, bills, order blanks, and other business forms.

PARCEL POST BUSINESS METHODS.

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NEED OF BUSINESS METHODS IN PARCEL-POST MARKETING.

MANY FARMERS already have a fairly satisfactory market and the increase in returns possible through direct marketing by parcel post would not pay for the effort expended. Some producers, however, have either a poor market or a product of good quality that might be sold profitably by employing the parcel post and shipping direct to housewives in cities. The steadily increasing number of packages containing farm produce arriving daily at the post offices of the larger cities proves that producers are gradually realizing the possibilities of direct marketing and are taking advantage of them.

Marketing by parcel post or by any other means of transportation direct from producer to consumer, however, is a satisfactory method of marketing only under certain conditions. The produce sent from producer direct to consumer always will constitute a comparatively small percentage of the total food supply. This is true because of the advantage of transporting most commodities in car lots, the prohibitive cost of parcel postage to the more distant zones, the fact that most purchasers prefer to see what they buy, and because of other economic conditions.

Without satisfactory business relations between producer and consumer parcel-post marketing can not prove a success. Any distrust that exists must be removed if success is to be attained. It is the

purpose of this bulletin to point out ways and means whereby the business relations may be made satisfactory to both parties.

While it may be attractive to a city dweller to believe that he can have a vegetable garden grown for him 100 miles or 150 miles away, place his orders for the cost of a stamp, and have the produce delivered at his door, it should be remembered that not all farm products lend themselves to direct marketing by parcel post. Usually it is impracticable to market such heavy products as potatoes by parcel post, whereas eggs, butter, sausage, poultry, many vegetables, and nut meats may frequently be shipped with profit and at a saving to the purchaser. In general the greater the value per pound the more favorable is the chance for direct marketing.

Since the direct marketing of farm products by parcel post is different in many ways from the ordinary plans of selling such products, the following suggestions and methods are given.

ESTABLISHING BUSINESS RELATIONS.

In practically every city there are persons who wish to buy fresh produce direct from the farmer, while within 150 miles (first and second parcel-post zones) of these cities there are many farmers who desire to market their produce by parcel post. The bringing of these persons into business contact is one of the most difficult problems of parcel-post marketing.

FRIENDS AND RELATIVES AS CUSTOMERS.

Naturally, first contacts are with friends or relatives. For producers who wish to market by parcel post the most satisfactory way of finding customers is to write to friends, relatives, or acquaintances in cities, seeking their trade. Purchasers, on the other hand, often can locate reliable producers by correspondence with friends, relatives, or acquaintances in the country. More than 75 per cent of the produce being marketed by parcel post in a number of cities in which investigations have been made is sent by persons who obtained their customers through friends, relatives, or acquaintances.

Making business contact is less difficult between friends because there is an absence of the suspicion and distrust that sometimes is found between strangers. Many persons will not order farm produce from strangers because they do not know the conditions under which the articles are produced.

Although the ways of obtaining customers are numerous, no method is so promising as that of working up a trade with or through friends. This method of establishing business relationship

is especially recommended for the general farmer who has a limited amount of produce. Those who wish to market a great deal of produce by parcel post may find it necessary to obtain customers by personally soliciting strangers or through advertising in newspapers and by other means.

SEEKING CUSTOMERS AMONG STRANGERS.

If a producer who desires to market produce by parcel post has no friends or acquaintances who wish to buy direct, or if a sufficient number of patrons can not be obtained among his friends, he must seek customers among strangers. This may have to be done by those also who wish to obtain a number of customers in a short time.

The farmer would do well to write to acquaintances, asking them to recommend him to others, or to supply him with the names and addresses of reliable acquaintances in town who might be interested in the proposition. The farmer should try to induce such friends to act as city references by answering inquiries and by giving general information. When the farmer asks friends to recommend him to others, he should supply them with full information so as not to make the matter burdensome. Where the business is to be on a scale which warrants the expense, it should be found effective to supply friends with neatly printed circulars describing the plan and giving lists and prices of produce. In the absence of a printed statement the farmer should supply such friends with one or more copies of a legibly written statement giving details.

In order to obtain satisfactory results from advertising in a newspaper, the paper selected must have a circulation among persons to whom the advertisement would appeal. Best results usually are obtained from the papers which carry special parcel post advertising departments, or which devote to that purpose sections among the classified advertisements. Very few papers have such departments. An inquiry eliciting replies from 635 postmasters shows that in only 17 cities are papers published which give special attention to advertisements for marketing by parcel post. Information received from persons who have advertised farm produce for sale indicates that usually advertising is not profitable for the general farmer, but often gives satisfactory results to the producer who specializes in some product that can be shipped throughout the year. Advertisements should be short and should give a description of the goods with the prices, and the name and address of the person advertising. In some cities the Sunday edition of a newspaper gives better results than the daily edition. The person who advertises must offer a product that is wanted by the persons who read the paper at the time the product

is advertised, in the places where the paper has a circulation. In other words, he must know what to advertise, when to advertise, and where to advertise.

The following advertisements are given merely as suggestions, as the wording can be changed to meet the conditions of each farmer:

FRESH EGGS direct from farm. Send ——— for three dozen delivered by parcel post prepaid. Fair View Farm, Blank, Va.

BUTTER direct from dairy. Fresh, clean, and sweet. Send ——— for two pounds delivered postpaid by parcel post. Fair View Farm, Blank, Va.

FRESH VEGETABLES for the family. Quality guaranteed. Send ——— for basket of assorted vegetables delivered postpaid by parcel post. Fair View Farm, Blank, Va.

CHERRIES from the tree to you by prepaid parcel post. Picked the day they are mailed. Send ——— cents for ——— quarts to Fair View Farm, Blank, Va.

Form letters, circulars, or cards sent to a selected list of persons have been suggested often as means of obtaining customers for produce by parcel post. In some cases in which this plan has been tried it has not been successful. Persons who wish produce of high quality sometimes will not order from a stranger who has not been recommended to them. The cost of obtaining customers by circularizing is often great, and unless the names of persons to whom the circulars are sent are selected very carefully this method of obtaining customers can not be especially recommended.

Some enterprising producers have secured valuable customers by using names and addresses selected from telephone and city directories. Indications of financial standing sometimes may be obtained by noting the business or profession and the section of the city where they conduct business or where they reside. This method, however, necessitates a knowledge of the character of various parts of the city.

Customers may be obtained by making a personal canvass in a selected neighborhood in a city. The neighborhood should be one which is not supplied with a great many markets or green grocery stores in order that the competition may not be as keen as it would be in a neighborhood that has excellent marketing facilities. A suburban district of homes with good incomes offers a good field in which to solicit trade. In many such districts the delivery service of the groceries is not as satisfactory as in the city.

Success in making a personal canvass depends in a large measure on the personality of the person making the canvass. He should state his business clearly and concisely, showing the prospective customer why it is advantageous to buy produce by parcel post. Soliciting trade should not be undertaken by a person who is not neatly dressed, as it is naturally assumed that a person who is careless in other matters will be careless in the preparation of produce that he has for sale. When soliciting trade it is advisable to have samples of produce to show what can be furnished. The samples should represent fully and honestly the produce to be supplied; if they misrepresent, failure is sure to follow. Cards giving the name and address of the producer and the nature of his marketing are useful. A personal canvass usually results in more customers than does advertising or the sending of form letters, as nearly everyone prefers to know the person with whom business is transacted.

If the producer's farm is on or near a much-traveled road an attractive farm bulletin board placed conspicuously near the road is a help to both producer and consumer in making business contact. Many city dwellers now travel far out into the country by automobile, and this fact can be turned to account in securing customers by using a bulletin board. This method will be especially useful on clean, well-kept farms. The statements on the board should give the articles for sale, together with their prices, delivered to the purchaser's door by parcel post, and the main items should be in lettering large enough to be read quickly. This plan has enabled a number of producers to secure all the customers they could supply.

Warning notices might be placed at a proper distance in each direction from the main bulletin board. The wording on these warning boards should be brief but pointed, such, for example, as "Fair View Farm. Read Marketing Bulletin Ahead."

The postmasters in 41 cities, under the direction of the Post Office Department, have instituted campaigns intended to foster parcel-post marketing. The names and addresses of producers, together with the kinds of produce offered, are listed free for distribution to the patrons of the offices; and some of these postmasters issue for distribution to producers lists of names of conumers who wish to buy. Many producers and consumers have established business relations by this method. For various reasons some have found their dealings unsuccessful. Much depends on promptness and on businesslike methods in answering correspondence.

A producer who wishes to have his name listed should write to the postmaster of the city selected, giving his name, address, the produce offered for sale, and prices. Persons in any of these cities can obtain a copy of the list on application to the postmaster either

by letter or in person. The cities in which campaigns have been instituted are as follows:

Athens, Ga.
Atlanta, Ga.
Austin, Tex.
Baltimore, Md.
Birmingham, Ala.
Boston, Mass.
Brooklyn, N. Y.
Chicago, Ill.
Cincinnati, Ohio.
Cleveland, Ohio.
Dallas, Tex.
Denver, Colo.
Detroit, Mich.
Galveston, Tex.
Greenville, S. C.
Hartford, Conn.
Indianapolis, Ind.
Jacksonville, Fla.
Kansas City, Mo.
La Crosse, Wis.
Lawrence, Mass.
Lincoln, Nebr.
Los Angeles, Cal.
Louisville, Ky.
Lynn, Mass.
Memphis, Tenn.
Minneapolis, Minn.
Nashville, Tenn.
New Orleans, La.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Oreg.
Providence, R. I.
Raleigh, N. C.
Richmond, Va.
Rock Island, Ill.
San Francisco, Cal.
Seattle, Wash.
St. Paul, Minn.
St. Louis, Mo.
Washington, D. C.

HOW THE CONSUMER CAN FIND A PRODUCER.

Many city dwellers who spend a week or more in summer in some neighboring country district could make it their business to become acquainted with farmers and complete arrangements for buying produce by parcel post. In parts of Europe many families consider the making of such arrangements an important feature of their vacation trips. Similarly, a farmer could make desirable connections by meeting city people on their vacations and perfecting arrangements for supplying their families with vegetables, fruits, eggs, or butter. Such meetings make it possible to settle all details and allow the customer to judge of the quality and character of the produce in advance.

Frequently, under such conditions, it is possible for city consumers to enter into arrangements with a farmer or gardener whereby he will agree to increase the amount of vegetables he grows in his farm garden and to raise certain specialties which the customers may wish to buy. This can even be extended into a sort of partnership arrangement in which the farmer manages a country garden to supply the city consumer's table. Under this arrangement the city consumer practically has a kitchen garden of his own, though it may be many miles distant.

In some instances the consumer will wish to make contact with a producer by inserting an advertisement in some paper known to circulate in the section of country in which he thinks a suitable producer may be found. Such an advertisement might read as follows:

> A BALTIMORE FAMILY of six wants a gardener or truck farmer to supply it regularly with fresh assorted vegetables by parcel post once a week throughout the year. For particulars address ———.

This is simply a suggestive form for such advertisements. The number constituting the family to be supplied, the frequency of shipment, and the portion of year during which the shipments are desired can be stated according to circumstances. For instance, some families might desire shipments twice a week, but none at all during the months of July and August because of absence from the city.

Another form for the advertisement may be as follows:

> WANTED—A farmer who takes pride in his vegetable garden to plant enough garden this year for his own family and a family of three in the city of ———. Write at once to ———.

Or it might read as follows:

> A CITY MAN desires to have a garden grown for him in the country. For particulars write to ———.

TRIAL ORDERS.

The producer who wishes a new customer should seek the privilege of making a trial shipment. A plan for the trial shipment should be worked out completely so that the prospective customer can be told the quality, quantity, and general variety that can be shipped and the total cost for such a shipment delivered at his house. If possible the size of the customer's family should be learned and an offer made of a shipment that will supply fresh vegetables to such a family for a specified number of days. If the prospective customer is known to be reliable the farmer should be willing, inasmuch as he wants to sell his goods, to make the first or sample shipment at his own risk. The condition should be made that the customer is to be judge of value received and that if the goods in the trial shipment are not entirely satisfactory in quality or in price the customer's opinion as to what they are worth will be accepted and the bill adjusted or a refund made. Where the reliability of the prospective customer is entirely unknown to the producer it is preferable to have a cash transaction with the first order. The producer should remember that the customer has no more business reason for trusting him than he has for trusting the customer, and should make it clear that he will be glad to make any adjustment necessary in the transaction so as to leave the customer entirely satisfied.

The situation is exactly reversed where the city family seeks to induce a farmer to ship products. It is only fair to send cash with the first order and continue the cash business until credit arrangements satisfactory to both sides can be established.

BUSINESS RELATIONS WITH CUSTOMERS.

Once contact has been made and shipping begun it is important that proper business relations be established and maintained, for on these depend success. The difficulty frequently met in obtaining the first order makes it important for the producer to use businesslike methods to retain the trade that he secures.

Whether a person is successful in parcel-post marketing depends largely on his adaptability to this work. If routine and detailed work is distasteful to him he may never learn how to keep up a business relationship. Thousands of persons who have been successful in obtaining customers have been unsuccessful in keeping them. Much has been learned from the experience of both successful and unsuccessful shippers.

The most important feature in a business relationship is a square deal. Good grading of produce, strict business honesty, prompt attention to correspondence and orders, and satisfactory adjustment of complaints are needed. The consumer as well as the producer should do his part in these matters.

FORMS.

If a farmer expects to develop a business of selling produce to strangers he will find it advisable to have printed stationery bearing the name of the farm, with envelopes to match. If the farm is not named an appropriate name should be selected. A simple, though attractive and businesslike letterhead can be printed without much cost. (See form 1.) It should give the name and location of the farm, the farmer's name, and a simple statement of the business. Elaborate and highly colored letterheads embellished with illustrations of buildings, fruits, or animals should be avoided.

FORM 1.—*Suggestion for letterhead.*

FAIR VIEW FARM.
John Brown, Proprietor.
PRODUCE SHIPPED BY PARCEL POST DIRECT FROM THE FARM.
Blank, Va., ————————, 191—.

Blank statement forms or invoices to fill in and inclose with shipments should be supplied. Persons receiving produce by mail wish to know the price of the shipment, and by the use of printed statement forms the shipper can furnish this information without much trouble. If it is not desired to use a printed form for each shipment, the price of the produce can be entered on a blank piece of paper, but the use of a printed statement form is recommended for those who send produce to persons who pay at stated times. Form 2 shows a form that may be used either for an invoice with each shipment or for rendering a monthly statement. A bill or statement covering more than one shipment must not be inclosed in a parcel, as it is first-class mail matter.

FORM 2.—*Suggestion for bill or statement.*

Blank, Va., ———————, *191—.*

M ———————— Dr.

To FAIR VIEW FARM,
John Brown, Proprietor.

Each parcel must bear the name and address of the shipper, the name and address of the person for whom intended, and the nature of the contents, such as "Fragile" or "Perishable." As tags frequently are torn off, it is best to have this information written or stamped directly on the outer wrapper or container. If the only mark of identity of producer and consumer is on a tag and the tag is lost, the parcel can neither be delivered nor returned to the sender.

Producers who have business enough to justify them may secure gummed labels worded somewhat as follows:

From
Fair View Farm,
John Brown, Proprietor,
Blank, Virginia.
PERISHABLE.
EGGS.

The wording may be changed to suit the product shipped, changing "Eggs" to "Poultry," "Butter," or "Vegetables," and "Perishable" to "Fragile," as the case may require.

These labels, if properly applied, should not come off. They will serve as an advertisement and may result in inquiries from other customers.

Books should be provided so that records can be kept of all shipments. There is no prescribed form or size for these books, but they should provide a permanent record of the date of shipment, customer's name and address, the product and quantity sent, the price and amount of bill, and the weight of shipment. Other data of value may be recorded, such as kind and cost of container, credit for return of containers, net amount of bill, and date of payment.

Form 3 shows a form which provides for such a record. This form can be of any size desired. The keeping of complete records of this kind requires considerable work, but it is desirable when the business is sufficient to warrant it. Such columns as are not wanted may be omitted from the form. If a farmer is shipping to but one or two customers it may not be advisable to keep such complete records, but some record should be kept of every shipment. If shipments are made to a number of persons, an alphabetical list of customers should be kept. Space can be provided in the front of the record book for

these names. The surname should be entered first under the proper letter, then the initials and address.

FORM 3.—*Suggestion for record of shipments.*

Date of shipment.	Customer's name.	Address.	Quantity shipped.	Kind of produce.

CORRESPONDENCE.

In conducting a mail-order business much depends on correspondence. Comparatively few persons like to write letters; consequently, producers should do all they can to carry on direct marketing in such a way as to require few letters from their customers. However, the very nature of mail-order business, even with the use of the most simplified system, necessitates correspondence. Farmers must learn to answer correspondence and inquiries from customers or prospective customers. This should always be done promptly, whether the answer is favorable or not. Many persons who have had their names listed by postmasters have failed to make any reply when they received inquiries. Business can be secured and retained only by using businesslike methods, which should be simple but must be prompt. The name and full address of the writer should always be given, as failure to do this often prevents reply to important business correspondence.

SIMPLIFYING MAIL ORDERS.

Every extra letter that the producer or consumer has to write is an obstacle to the establishment of parcel-post business; it is an added cost and source of lost time and annoyance. It is therefore highly important in getting a customer to give a trial order, and at every stage of later ordering to reduce as far as possible the amount of writing that must be done.

The first letter sent by the producer in seeking to establish parcel-post marketing relations should explain the plan clearly, anticipate all usual questions, and should tell the customer exactly what can be furnished and how much, exactly the amount of money the goods will cost delivered, and when and how they will be delivered. Similarly the customer in seeking a producer should tell as explicitly as he can what he wants, when he wants it, and should give a general idea as to prices. The first letter also should establish clearly the reliability of the writer. Unless all these points are fully covered at the start, both producer and consumer may feel uncertain about proceeding further in the matter.

FORM 3.—*Suggestion for record of shipments*—Continued.

Kind of container.	Weight.		Local country price.		Cost of container		Postage.		Amount of bill.		Credit for container returned.		Net amount of bill.		Date of payment.
	Lbs.	Oz.													

REDUCING HANDWRITING TO A MINIMUM.

The plan which calls for the least correspondence is the regular weekly shipment of a definitely priced assortment of products, the producer first learning what the consumer wants and what he does not want. If this plan is not used it is necessary for the farmer to send his customers, from time to time, a list of the products he has for sale and their prices. The customers then make up their individual orders for such goods as they desire.

The writing of such a list each week by hand will be found very troublesome, particularly if the producer has several customers, each of whom must be supplied with a copy. This labor may be avoided by having printed or mimeographed lists of all the products that will probably be available for sale during the season. After the name of each product there should be a blank space in which the current price of that product may be entered. Before each name another blank space should appear, in which the customer can enter the amount of that product wished. He can then return the list as an order. As shown in Form 4, this sheet can be so worded as to constitute a price list, an order blank, and a statement of products which will be available one or two weeks ahead. Prices can be inserted in such a list quickly and it is equally easy for the customer to indicate his wishes for the next shipment.

FORM 4.—*Suggestion for order card for cash customers.*

———————, 191—.

To Fair View Farm,
Blank, Va.:

Enclosed find $———, for which please send me by parcel post, charges prepaid, items I have checked.

——— doz. eggs @ ——— per doz. $———
——— lbs. butter @ ——— per lb. ———
——— lbs. dressed poultry @ ——— per lb. ———
——————— @ ——— per ——— ———
——————— @ ——— per ——— ———

Total, $———

[Sign here] ———————————
Street and number ———————————
City ——————— State ———————

Postage extra beyond second zone.

A similar card could be used for credit customers. This should be supplied with name and address for return and should be stamped. The wording should be changed by omitting the words "Enclosed find $——— for which."

An easier means of sending out price lists for securing orders is the double or return postal card. The list should be printed on the back of the return half of the card, while the producer's name and address are written or printed on the face. The first or initial half of the card should bear on its face the name and address of the customer, and the back may be used for comment on the availability of certain fruits or vegetables, or for any other necessary correspondence. The customer can tear off the reply half, indicate the amount of each article wanted, sign his name, and mail the card. This system costs in postage but little more than one letter, while the system outlined in the preceding paragraph requires two letters, one from the farmer to the customer and one in return. Both producer and consumer are saved the cost of an envelope and the trouble of folding and sealing. In addition, the customer is saved the trouble of addressing an envelope and the cost of a stamp.

Another plan is for the producer to have his list of articles printed on postal cards, with spaces to enter prices and for the consumer to enter the order.

Should the farmer not care to buy stamped cards, he can have the price list printed on the back of a self-addressed mailing or post card, which is forwarded to the customer in an envelope. The customer needs only to fill in the card, affix a stamp, and mail.

The cost of issuing a price list in blank could be reduced materially by the cooperation of several farmers. Such a list should show all the products raised by the group, but could be used by each individual producer in dealing with his own customers.

Where such brief forms are used, however, the farmer should occasionally write a personal card or note to his customer to show interest, explain seasonal changes in the nature of shipments, or furnish information as to fruits or vegetables soon to be ready for market. This may be done on the initial half of the return postal card. If possible, space should be left on the return half of the postal card for the customer to note the condition of the previous shipment or make suggestions as to goods desired.

DETERMINING PRICES.

Many farmers have an erroneous idea as to the prices that city dwellers are willing to pay for farm produce. On the other hand not a few city purchasers think that the farmer receives a very low price for his produce when he sells it locally. In attempting to market by parcel post, farmers too often ask exorbitant prices, and

city consumers often expect to receive produce at prices which would allow no profit to the farmer if he sends small quantities by parcel post. The parcel post offers inducements to farmers who have products of good quality and who can not market to advantage in large quantities, and to consumers who wish produce direct from the farm. Consumers will not pay more than the city price unless a superior article is obtained. Farmers will not market by parcel post unless they can obtain enough over their local price to pay for container, postage, and extra labor. A proper understanding of both sides of this question will assist both producers and consumers in agreeing on prices. Consumers should bear in mind that most farmers sell ungraded produce locally, and if graded produce of high quality is furnished by parcel post, a higher price must be expected.

It is advisable to have some basis from which to figure prices of certain kinds of produce, as misunderstandings and distrust about prices have caused much dissatisfaction with direct marketing. The use of the local country price or the wholesale city price as a basis has proved satisfactory in most cases. The farmer can readily ascertain the amount that he must charge above his local price, when he considers the cost of container and postage, and the extra labor involved. If satisfactory to both producer and consumer, a contract price for a stated period can be made. An agreement must be reached as to whether or not the price includes all charges for produse, container, and postage. It has been found that purchasers usually prefer to have quoted to them a price which includes all charges. Whatever agreement is made as to prices, the farmer should abide by it strictly and give his customers no cause for distrust.

PRICES BY THE YEAR.

Because of unequal production and wide variation of prices it has proved difficult for persons to agree on a uniform year-round price for produce engaged by the year. Only when the producer can fill orders at all seasons of the year and each party is sure of the reliability of the other is this plan the best. Usually, when eggs or other farm products are high in price and production is small, the farmer must stop shipments temporarily, which is hardly fair to the consumer who has paid more than the market price through the summer with the expectation of receiving produce in winter at a price lower than the market quotations. Nor is it fair after the farmer has shipped eggs at a low price through the winter for his customers to inform him that they are to take a vacation of a month and will not need eggs during July, when he has been expecting to make a profit.

CITY MARKET REPORTS.

Many farmers and most city consumers have daily market reports available in the newspapers and may base prices on them. Un-

fortunately such reports vary in different newspapers, and often producers and consumers do not see the same reports. Where a producer and a consumer receive the same newspaper the market reports may prove satisfactory as a basis for determining prices.

ALLOWING THE FARMER TO FIX THE PRICE.

If an order blank is not used and the consumer is assured that the farmer understands business methods and is conscientious and fair-minded, he may allow the farmer to set the prices after the order is received. Protests may be made at any time, and if developments are unsatisfactory trade may be stopped. Many consumers have used this method with satisfaction to themselves and the farmer. The local country price may be used by the farmer as a basis from which to determine the amount to be charged. There is danger that some producers will overcharge because of an erroneous idea of city market prices or because of a lack of knowledge of basic business principles. Reports of high city retail prices should not receive serious consideration as a basis, for such high prices usually are of short duration and often represent the sales of fancy articles to a few wealthy consumers.

ALLOWING THE CONSUMER TO FIX THE PRICE.

Some farmers furnish produce at prices that are determined by their customers. This plan is acceptable to very few farmers—in fact, only to those who have a great deal of confidence in the persons to whom produce is sent. Consumers can use their city retail market price as a basis for determining what they care to pay. For this plan to be satisfactory to both parties the consumer either must effect a saving or obtain a better product, while the farmer must receive a better price than he can get at his local market.

FIGURING PRICES IN ASSORTMENT SHIPMENTS.

Unless confidence between buyer and seller has developed to such an extent that the producer feels free to ship on his own judgment, with the certainty that the consumer will accept his price as fair, the producer selling from list must give great care to determining the gross price he is to ask and his net profit. This is somewhat difficult, as the producer must bear in mind the bulk and weight of vegetables and fruits, the weight of container and packing, and the bulk that he can get into a package, with reference both to postage and to size and weight limits of parcel-post packages. The cost in time and material for proper packing also must be considered. The shipments should be adjusted so that the quantity of each variety shipped will be enough for a proper serving of the family for which it is intended. In endeavoring to satisfy the customer the producer also must bear in mind, more or less, the retail prices for similar products

in the cities. In making an assortment especial care must be exercised not to include in it too much of a heavy and low-priced product, but to give the customer good total value.

Possibly the easiest way for the farmer to make profitable assortments is to determine what he wishes to receive net for each product and then, after figuring out the weight or bulk of a typical portion, to add a proper allowance for postage and packing. If he can figure his price throughout in terms of pounds it will be easy to figure the delivery price, including postage. But after some experience the producer should be able to distribute cost of packing and postage on a percentage basis. Under this plan he can easily determine how many pounds of each product he can afford to include for a given gross price, including postage.

When the price is to cover the return postage on the containers this item should be included with the postage. The easiest plan of settling for postage on return of containers, if the customer buys the stamps, is to deduct this amount from the price of the next shipment following the return of the containers. An addressed return tag for use on the empty containers should be furnished by the farmer.

ARRANGING FOR PAYMENTS.

Difficulty in arranging for payments hinders the growth of direct marketing. The farmer prefers cash in advance for his produce. This system is not satisfactory to many consumers because of the necessity of making frequent payments and because the exact price is not always known. However, the farmer should never send produce without payment in advance to a stranger who has not exchanged recommendations with him. Although the majority of persons are honest and will pay for produce received by parcel post, unfortunately there are persons who order farm products without intention of paying. A few such losses will reduce the farmer's profits materially.

Consumers who have not been recommended should not expect producers to send goods by parcel post without having received payment. It is easier for producers to furnish satisfactory references than for many persons in cities, as in the country nearly everyone is known by the postmaster and banker. If a producer furnishes satisfactory references the consumer should be willing to send cash in advance until the producer has opportunity to learn of the reliability of the person to whom he is sending produce.

If a prospective customer furnishes references the producer, before sending produce, should write to the persons to whom he has been referred, as anyone, no matter how unreliable, can send the names of persons as references. In many instances producers have been satisfied when the mere names were furnished, and no effort

has been made to ascertain the reliability of the person who sent the names. When unable to collect the money for produce sent, these farmers have learned that the persons whose names had been used as references were no more reliable than those who had furnished the names. Persons whose names are furnished by prospective customers should be business or professional men if possible.

If a producer is satisfied as to the reliability of his customers, credit should be extended and settlements required periodically, preferably each month. This will prove more economical and satisfactory than the cash-in-advance system. An invoice should accompany each shipment and the bill sent in at the end of the month should be a summary and total of the various invoices.

Producers who wish to market certain of their products direct to the consumer by parcel post should consider that they are entering upon a small retail business, where they must necessarily encounter the disadvantages under which a retailer always labors. One of the most difficult of these is the proper use of credit. Many retail business houses have been ruined by the refusal of such credit and others by the too liberal extension of it.

When properly used the extension of credit to customers buying by parcel post is often satisfactory, but it must be remembered that extending credit is a business proposition and requires a knowledge of business relationship.

The collect-on-delivery service of the Post Office Department may be used to advantage when sending packages of considerable value, but it is thought by most persons to be too expensive for ordinary farm produce shipments. However, when this service is used, it eliminates all danger of loss of payment.

INSURANCE OF PARCELS.

For 3 cents the producer may insure a parcel with the Post Office Department against loss or damage for the actual value of the contents up to $5. For parcels of a greater value a higher fee is charged. For those desiring it, this service provides an inexpensive method of avoiding financial loss by the missending or breakage of parcels. It has been found that actual loss of parcels or damage to them is usually very small.

QUALITY AND APPEARANCE OF PRODUCE.

It has been shown that the consumer can not expect to receive produce by parcel post at a price much lower than the local retail price. The producer's appeal to customers, therefore, is largely through the quality and appearance of his produce. The consumer has come to expect a uniform product and will not be satisfied with a shipment of miscellaneous ungraded produce. As the sending of anything but high grade material will result in failure to retain

trade, and as many persons have discontinued ordering produce by parcel post because they received one shipment that was unsatisfactory in quality, it is better for a producer to reject an order than to send such goods. The produce should be uniform in size, color, and quality and should be packed so that the contents and container will carry properly, arrive in good condition, and present a satisfactory appearance.

Quality is very important, but probably more produce is judged by appearance than by quality. Some farmers are prone to think of the likes and dislikes of the purchaser as whims and fancies, whereas, as a business principle, he should endeavor to cater to the desires of his customers. It is known that white eggs sell better in New York, while brown eggs bring a premium in Boston. The average farmer cares little whether eggs are white or brown, but this indifference should not govern what he sends to customers.

VARIETIES OF PRODUCE AND CONTINUOUS SUPPLY.

Many persons do not market by parcel post because they do not have a large variety of produce or because their supply is available only part of the year. While it is true that a continuous supply of a number of products is more satisfactory to customers, such a supply is not absolutely necessary in order to establish a parcel-post trade. Many persons have secured customers by specializing in one or two kinds of produce, such as butter or eggs, which can be supplied during the entire year, and then these customers have offered an outlet for other commodities which can be furnished only occasionally or for produce which is rarely to be had on city markets. In most of these cases it was necessary only to send a letter or card to satisfied regular customers asking them if they wished to obtain certain kinds of produce that were for sale at that time. Such letters tend to keep up a personal relationship between the producer and his customers which makes it easier to keep up business relations.

CONTAINERS.

The cost and treatment of containers have much to do with success in marketing by parcel post. A container should be cheap, neat, and light. The amounts involved in most parcel-post shipments of farm produce do not warrant the use of an expensive, heavy package because of the first cost and the charges for postage. The container should be adapted to the particular produce shipped and should be whole and clean.

The trouble of returning empty containers often influences people to discontinue parcel-post marketing. The city dweller often has little room to keep containers, and it is not practicable to return them singly, for the cost of postage is high on small shipments. Then, too, it is often inconvenient to take a bulky package to the

post office station. If the customer can not conveniently store them and return three or four at one time the producer should, if possible, use containers that are cheap enough for a single service. Containers should never be bought with price as the only consideration, however, as they should be strong enough to carry the contents safely. For many shipments cheap splint baskets are satisfactory and the cost is so small as to make the return of them unnecessary. Any plan concerning the return of containers should be clearly understood by both producer and consumer before shipments are made.

ADJUSTING DIFFERENCES.

The producer who establishes a mail-order business in farm produce must expect to receive complaints. Upon receipt of a shipment a customer may be dissatisfied with the quality or appearance of the produce, which may have been caused by rough handling or delay in delivery. Often when shipments of this kind are received a customer writes a letter to the producer accusing him of unfair business methods. In instances of this kind the producer may be tempted to write a discourteous letter in reply, but he must bear in mind that no business man can afford to do so, no matter how unfair the letter received may seem.

The success of persons who have sold goods by means of mail orders is due largely to their guaranty to give satisfaction or to refund the money. Because they have adhered strictly to this guaranty the confidence of the buying public has been firmly established and, through recommendations of satisfied customers, the business has grown from year to year. Many customers who were dissatisfied with the quality of produce received from a person who sold by mail later became satisfied customers and good advertisers because of a prompt adjustment of the matter. There is no better way of establishing confidence and eliminating distrust than by the prompt adjustment of differences. If a producer becomes convinced that a customer is unfair and unreasonable he should write a letter telling him that his trade is no longer desired. This letter should never be discourteous, if for no other reason than because antagonism never pays profits to a person in business.

If, in all dealings, a producer is prompt, fair, and reliable, he will be able to obtain and retain business that otherwise would be lost. A producer who undertakes a business in parcel-post marketing can not hope to make great profits nor to build up a large business in a short time, but proper business relations with consumers probably will insure success and an increase in business.

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FUMIGATION OF CITRUS TREES

R. S. WOGLUM
Entomological Assistant, Tropical and
Subtropical Fruit Insect Investigations

FARMERS' BULLETIN 923
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. March, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

THIS bulletin contains a general account of the approved methods of fumigating citrus trees with hydrocyanic-acid gas to control scale insects and white flies. It deals with methods of procedure, necessary equipment, chemicals of fumigation, and effect of the gas on insects and plants, and includes dosage schedules to be employed for the control of the various common citrus pests.

FUMIGATION OF CITRUS TREES.[1]

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WHAT CITRUS FUMIGATION IS.

THE FUMIGATION OF PLANTS with hydrocyanic-acid gas for the destruction of insect pests is one of the most important discoveries in the field of insect control. No other known gas so quickly destroys insect life and at the same time has so wide a range of usefulness. It was first used as an insecticide in 1886 by the late D. W. Coquillett, an agent of this department, for controlling certain scale insects on citrus trees in California. The immediate success and rapid development of the gas treatment in that State resulted in the almost complete abandonment of spraying as a means of controlling citrus scale insects, and led to the introduction of fumigation into other citrus regions of America, as well as into most of the important foreign citrus-producing countries.

The directions given in this bulletin are specifically for the control of scale and related insects infesting citrus trees, although, with proper modification, they will apply to the control of similar insects on other trees and plants.

Orchard fumigation for the control of citrus scale insects consists of covering trees with cloth tents, and liberating hydrocyanic-acid gas beneath these tents. The exposure of the insects to this gas for a definite period, varying with the insects to be controlled, will result in their destruction. In this connection the effect of the gas upon the plants, as well as upon the insects, must be considered.

[1] For a detailed report on fumigation in California see Bulletin 90 of the Bureau of Entomology, United States Department of Agriculture, published in 1911. This may be obtained for 20 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

CAUTION.—*Hydrocyanic-acid gas is colorless and is one of the most deadly poisonous gases known. It has an odor much like that of peach pits. In case of accidental inhalation of the gas, the person affected should be kept in the open air and required to walk to increase respiration.*

EQUIPMENT REQUIRED IN ORCHARD TREATMENT.

Orchard fumigation requires special equipment, comprising tents, poles for placing them over the trees, containers for the chemicals, and apparatus for generating the gas.

TENTS.

Flat cloth tents of octagonal design (fig. 1) are employed for orchard fumigation. To avoid waste of cloth in cutting, these tents are constructed of standard sizes based on the distance between parallel sides. The sizes commonly used are 36, 41, 43, 45, 48, 50, 52, 55, 64, 72, and 81 feet.

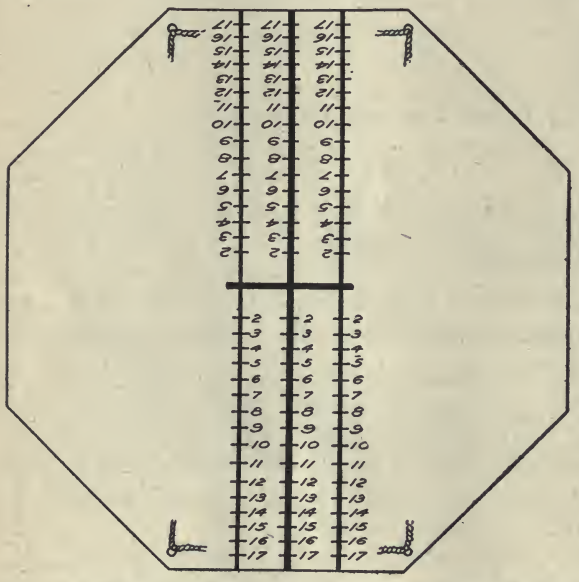

FIG. 1.—Fumigation tent marked according to the Morrill method.

In purchasing tents the orchardist should be guided by the size of the trees to be fumigated, making due allowance for their normal growth. Tents 36 or 41 feet in size should be used for citrus trees up to 10 feet in height; 41, 43, or 45 foot tents for trees 11 to 15 feet in height; 45, 48, or 52 foot tents for trees 16 to 20 feet in height; and 55, 64, or 72 foot tents for trees 21 to 25 feet in height.

The number of tents required depends largely upon the acreage of trees to be treated. In California the average commercial outfit contains from 25 to 60 tents. The usual length of exposure is one hour, and under the most favorable conditions one tent will cover 12 trees a night, though the average for the whole fumigation season approximates 8. One tent, therefore, should cover 90 trees (1 acre approximately) in 11 or 12 days, or 30 tents should cover 10 acres in 4 days.

MATERIAL.

Material for tents must be of the tightest possible weaves, comparatively light, and of sufficient strength to prevent tearing when trees are being covered. Heavy stiff tents are not only difficult to

manipulate but they break branches, injure fruit, and, moreover, will not fit closely to the ground around the trees, thus permitting rapid escape of the gas.

The materials now in general use for sheet tents are 6½-ounce and 7-ounce special drill, 8-ounce double-filled duck, and 7-ounce and 8-ounce special Army duck. A special, closely woven, 8-ounce United States Army duck is recommended as superior to any other cloth for fumigation tents, as it is strong and durable and retains the gas much better than the other grades of cloth.

CONSTRUCTION.

Experienced tent or awning makers are competent to construct these tents.[1] In fact, several firms in this country, particularly in California, specialize in their construction. To secure a tent actually the size required, due allowance must be made for shrinkage of new cloth. For example, a 43-foot tent of new cloth will shrink approximately 3 feet in length and half a foot in width after becoming wet, and other sizes will be reduced proportionately.

MARKING.

The prevalent system of fumigation requires special marking of the tents. Accurate marking is possible only after the cloth has been shrunk, which is easily accomplished by spreading the tents on a flat, open place where they can be saturated with water. Treatment for mildew, described later, also produces a shrinkage of the cloth. Untreated, factory-marked tents required due allowance for shrinkage.

A plan of marking tents that was devised by Dr. A. W. Morrill[2] is shown in figure 1. Three parallel lines running in the direction of the strips of cloth are graduated at intervals of 1 foot. The middle of each line is considered zero, and the numbering should be outward from this point. The distance between the parallel lines depends on the size of the tent. Three feet has been found to be an appropriate distance for tents up to 45 feet in size, and 4 or 5 feet in larger tents. The middle line should pass through the center of the tent. Where many tents are to be marked, a large stencil will facilitate the operation. The numerals should be at least 6 inches in height and can be made with printer's ink, lampblack and turpentine, or a soft, flexible, black paint.

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[1] A method of constructing fumigation tents is described in detail in Bulletin 90 of the Bureau of Entomology, United States Department of Agriculture.

[2] Morrill, A. W. Fumigation for the Citrus White Fly as Adapted to Florida Conditions. U. S. Dept. Agr. Bur. Ent. Bul. 76, p. 31. 1908.

MILDEW-PROOFING.

In a dry climate such as prevails in California tents are not usually treated to prevent mildew. Extensive handling resulting in acid burns and twig tears, rather than deterioration of cloth from mildew, is the chief reason for casting aside long-used tents in this State. In Florida, as well as in tropical countries where tents become wet every night, treatment to prevent mildew is necessary.

The dipping of tents in a solution of tannin to render them proof against mildew has been done for a long time and is very satisfactory. Tents are dipped in a vat containing the hot tannin solution (40 pounds extract of oak bark to about 100 gallons of water) for about 30 minutes, and then spread on the ground to dry. Contrary to the usual belief, the tannin treatment does not increase the gas-holding power of the tent, though it appears to increase its wearing quality. Tents also may be rendered mildew proof by permitting saturation in a hot solution of soap (¼ pound to 1 gallon of water) and then digestion for 12 hours in a solution of alum (½ pound to 1 gallon of water). An excellent formula, which also waterproofs, consists of immersing canvas for 24 hours in a solution of 1 pound of soap to 50 gallons of water, after which the material is placed for 3 hours in a solution of 1 pound of alum and 1 pound of sugar of lead to 6 gallons of water. There are other satisfactory treatments which render canvas mildew proof, yet not stiff or heavy. Many tentmakers have special methods for mildew-proofing cloth.

GAS-PROOFING.

At present no satisfactory method has been found for gas-proofing tents without rendering their use impractical under the rough handling to which they are subjected in orchard fumigation.

HANDLING.

The life of a tent normally will range from three to five years, depending upon the extent of its use and the care accorded it, as well as the weather conditions to which it is subjected. In dry climates tents should last five or more years, provided they are handled carefully and well aired before storage. Wet tents should be spread out on the ground between the trees to permit the air and sun to reach them during the day. If very wet, they should be turned over once or twice, and in cool weather they should be pulled partly over a tree. At the close of the season tents should be dried thoroughly, rolled up, and stored in a dry room, *but never on a dirt floor.*

POLES AND DERRICKS.

Either two wooden poles or two derricks are used in placing tents over trees.

The lengths of poles commonly used are 14 feet and 16 feet. Eighteen-foot poles are needed occasionally for large trees. These poles average 2 to 3 inches in diameter, are rounded, and made of straight-grained, well-seasoned hard pine free from knots. In the Gulf Coast States seasoned cypress is a cheap and satisfactory material for poles. Cypress wood does not need to be milled, as the trees grow straight and slender. It is advisable to have an extra set of poles on hand in case one set is broken. The lower end should be sharpened slightly so that it will hold firmly in the ground, while the upper end, to which a rope is attached for the purpose of erecting the poles, should be narrowed bluntly or rounded in accordance with one of the methods suggested in figure 2. The ropes should be ½ or ⅝ inch and about 3 feet longer than the pole. A stout piece of rawhide is sometimes substituted for the first 3 feet of rope adjacent to the pole, as this section, being half hitched over the tent each time the pole is used (see fig. 10, p. 19), suffers the most wear.

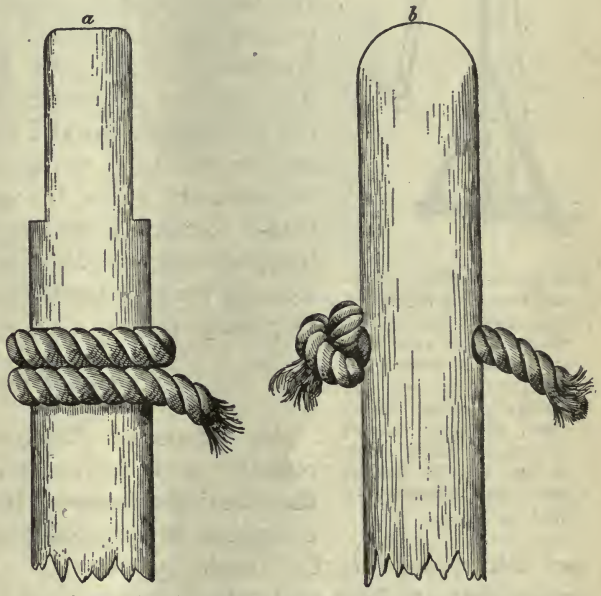


FIG. 2.—Ends of hoisting poles used in placing tents over trees: *a*, Used with tents where rings are present; *b*, used with tents having no rings.

In covering very tall trees it is necessary to use derricks with uprights about 3 feet higher than the tallest trees. Derricks usually are made of the same material as poles and have a framework attached to the bottom to prevent slipping and to confine the movement to one of two directions when the other end is raised. A rope and pulley arrangement is placed at the top for raising the tent, and the rope should be approximately three times the length of the pole. The uprights in common use average between 25 and 35 feet

FIG. 3.—A derrick, showing rope and tackle arrangement for raising tents: *a*, Guy rope used in holding derrick in upright position; *b*, pulling rope for raising tent; *p*, upper pulley; *c*, ring to which lower pulley, *p'*, is hooked when not attached to tent.

in length, with the top 2½ to 3½ inches and the bottom 3½ to 4½ inches in diameter. The construction is shown in figure 3.

GENERATORS.

Under the pot system of fumigation, earthenware vessels, heavily glazed to prevent weakening by action of the acid, are required for generating hydrocyanic-acid gas under the tent. The type of vessel commonly used in California is shown in figure 4. Covers for generators should be used to prevent injury from spattering of the acid during gas evolution. These covers prevent tent burning, distribute the gas rapidly toward the bottom of the tree, and reduce to a minimum injury to foliage immediately above the generator. The generator commonly used holds from 1½ to 2 gallons, although a 1-gallon size is used occasionally for small trees and a 3-gallon size for very large trees.

CHEMICAL WAGONS.

An apparatus of some sort is required in orchard work for carrying from tree to tree the chemicals necessary in fumigation. Figure 5 represents a specially equipped cart which was introduced into California by this department in 1908 and which subsequently has gained wide usage. Such a cart can be drawn either by the men of the outfit or by a horse. Some fumigators prefer to use a horse-drawn wagon rather than a cart for carrying the chemicals, with the result that a number of very original and ingenious combinations have been devised.

FIG. 4.—A fumigation generator, with cover device.

OTHER EQUIPMENT.

Glass graduates of 16-ounce or 32-ounce size are used for measuring acid and water. Other necessary apparatus includes rubber gloves, cyanid scoop, lantern or torch with supply of kerosene, large earthenware

pitcher for holding acid before it is poured into the acid jar, lead or copper funnel, large water pail, two to four 10-gallon glass acid carboys in stout wooden frames with handles, a covered tin-lined box large enough to hold 200 pounds of cyanid, barrels for water, thermometer, hygrometer, 75-foot tape line, and schedule cards of fumigation dosages.

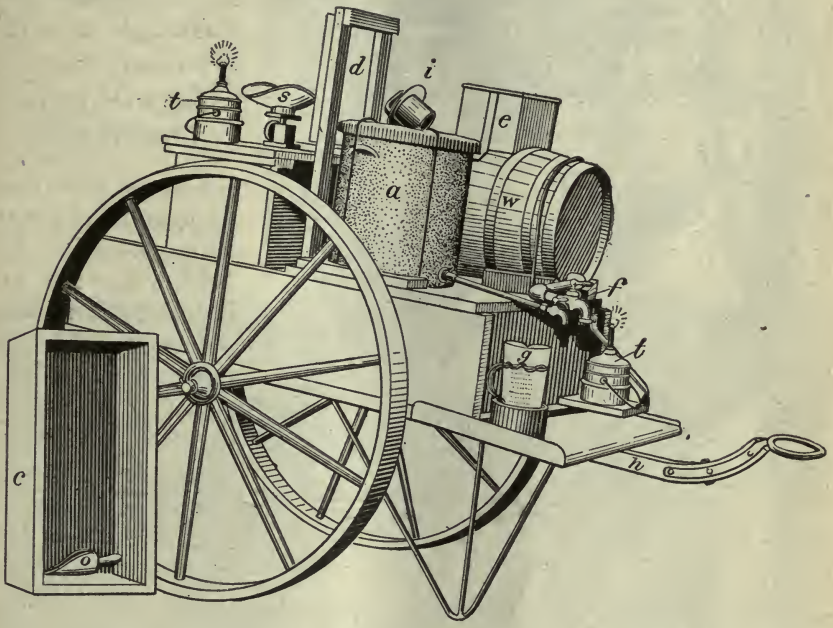


FIG. 5.—Supply cart for carrying chemicals: *a*, Acid jar; *i*, cover fitting into opening of acid jar; *w*, water keg; *e*, funnel for pouring water into keg; *f*, faucets for drawing water and acid; *s*, cyanid scales; *d*, schedule board; *t*, *t*, torches; *g*, graduate; *c*, cyanid box; *o*, cyanid scoop; *h*, cart handle.

FUMIGATION MACHINES.

A fumigating machine that has been in use in California (fig. 6) consists of a large generating drum mounted on two wheels and provided with shafts. Above the generating drum are two tanks, one for cyanid solution and the other for sulphuric acid. The liquid from each of these tanks is conducted to a measuring cylinder, from which it flows through a cut-off valve into a tray suspended within the large generating drum. The resulting gas passes from the generator to the tent through a large hose, while the residue remains on the bottom of the drum.

Another fumigation machine used in California (fig. 7) consists of two tanks, one above the other, the lower containing a mixture of equal parts of sulphuric acid and water, while the upper contains the cyanid solution. By the action of a suitable pump measured quantities of the

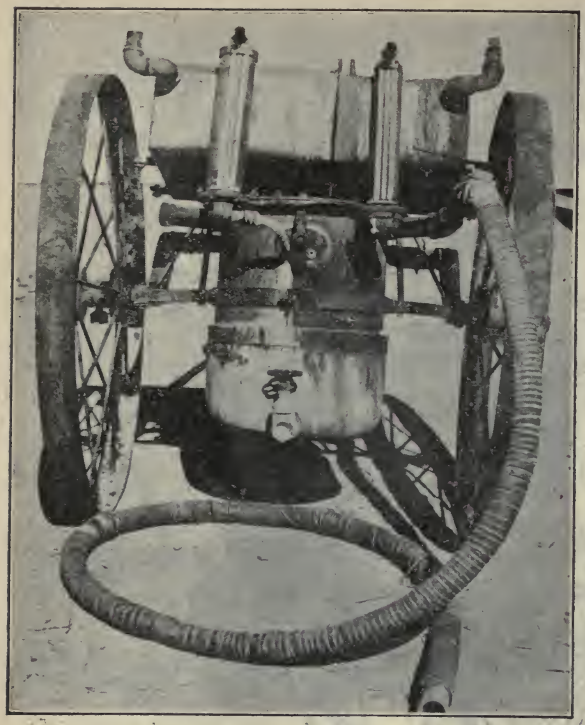


FIG. 6.—A fumigating machine that has been in use in California.

cyanid solution are forced into the tank containing the acid-water mixture, and the gas instantly generated escapes to the tented tree through a large hose.

CHEMICALS OF FUMIGATION.

Cyanid of sodium or cyanid of potassium, sulphuric acid, and water are necessary for the generation of hydrocyanic-acid gas.

CYANID.[1]

Either sodium cyanid or potassium cyanid, in the crystal form, can be used in fumigation. Potassium cyanid was used exclusively up to 1909, but since that date has been superseded by sodium cyanid.[2] Considering the world's limited supply of available potassium salts, there is little likelihood that potassium cyanid will be used again extensively in orchard fumigation.

Sodium cyanid for fumigation purposes should be of 96 to 99 per cent guaranteed purity, thus containing not less than 51.3 per cent of cyanogen. The volume of gas liberated is governed directly by the purity of the cyanid. The dosages for different insects are based on pure cyanid, and poor results are likely to follow if impure chemicals are used. *Too much stress can not be placed on the importance of purchasing high-grade cyanid*, in view of the fact that much of this material on sale by retail druggists is very impure, and thus unsuited for fumigation.

The purchaser will be protected if he obtains a cyanid guaranteed under the Insecticide Act. The analysis on the label should indicate that the cyanid is at least as pure as the following:

[1] All recommendations made in this bulletin are for sodium cyanid 96 to 99 per cent pure. For the use of potassium cyanid see Bulletin 90 of the Bureau of Entomology, United States Department of Agriculture.

[2] See Bulletin 90, Part 2, of the Bureau of Entomology, page 83.

SODIUM CYANID (NaCN), 96 TO 99 PER CENT.

Analysis.

		Per cent.
Cyanogen (CN)	not less than	51.3
Sodium (Na)	not less than	43.7
Inert substances	not over	4.0
Chlorids	not over	1.4

Cyanid is decomposed by the action of moisture, and should be protected from dampness by storage in a tightly covered tin box. If a box of cyanid is to stand for several days without being used, fill the empty space with old cloth or burlap to prevent exposure of the cyanid to air. Unused cyanid at the end of the season's work should be placed in as small a tin as possible and tightly sealed. High-grade cyanid for chemical use can be purchased in cases of 50, 100, or 200 pound sizes.

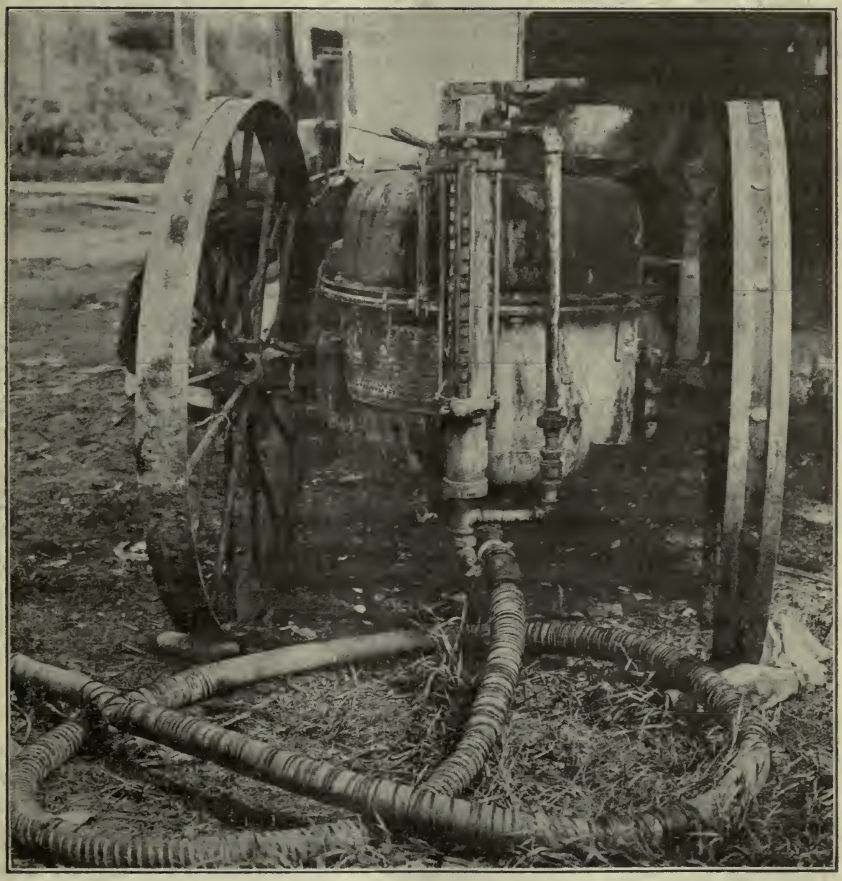


FIG. 7.—A fumigating machine used in California.

SULPHURIC ACID.

A commercial sulphuric acid (H_2SO_4) 92 to 94 per cent pure (66 degrees Baumé), free from nitric acid, arsenic, lead, and zinc, should be used. It does not matter whether the acid is made from pyrites or from pure brimstone, provided all impurities are eliminated. Acid is usually purchased in large iron drums holding from 1,500 to 2,000 pounds. It can be purchased also in glass carboys of about 10 gallons capacity. Pure acid is colorless and about twice as heavy as water, its specific gravity being 1.83. If stored in iron drums it frequently has a slightly milky color, especially toward the bottom of the drum. This color is due to sulphate of iron, produced by acid coming in contact with iron either before or after the acid is placed in the drum. This sediment in no way affects the value of the acid, unless it is present in excessive quantities.

Acid may be removed from drums in the field, although it is preferable to convey it thither in 10-gallon glass carboys. Acid will burn the flesh or destroy the clothing quickly, and care should be observed in its handling. Should acid come in contact with the flesh, wash the affected parts quickly with water. The use of rubber gloves in handling the acid containers is advisable.

HOW TO GENERATE HYDROCYANIC-ACID GAS.

THE POT METHOD.

Fumigation with hydrocyanic-acid gas was developed to its present stage of efficiency under the pot method, the gas being generated in a vessel under a tent by combining cyanid, sulphuric acid, and water in a glazed earthenware vessel. For each ounce, by weight, of sodium cyanid 1½ ounces, liquid measure, of sulphuric acid and 2 ounces of water are required to evolve the maximum volume of gas and carry the reaction to completion. This is known as the 1–1½–2 formula. This gives satisfactory results under field conditions, although some fumigators prefer to use 1¼ ounces of sulphuric acid to each ounce of sodium cyanid. For large dosages the latter formula appears quite satisfactory, but in the case of small dosages undissolved cyanid frequently remains and is a cause of complaint.

MIXING THE CHEMICALS.

In mixing the chemicals the water should be measured first and poured into the generator. Next, the acid should be measured and added to the water. This acid-water solution will become very hot. Then the generator should be placed at once beneath the tented tree, and the required amount of cyanid added. The operator can avoid contact with the hydrocyanic-acid gas, which is liberated immediately,

by placing the cyanid into the acid-water solution at arm's length. The foregoing procedure should be adhered to closely. *Acid must not be poured into a cyanid-water mixture, as a violent reaction will result.*

The acid-water mixture never should be allowed to cool before the cyanid is added, as a heated solution is necessary for a complete generation of gas. The cyanid should be in lumps averaging about the size of an English walnut, and small pieces should be used only in small dosages. A charge composed entirely of powdered cyanid results in a violent reaction, which is dangerous.

SMALL DOSAGES.

In field fumigation generators of the same size are used frequently with both small and large dosages. In general the results from dosages not exceeding 3 ounces of cyanid are less satisfactory than those from larger dosages, since with the former there is often an incomplete generation of the gas. For the best possible generation there must be enough liquid in the generating vessel to cover the cyanid completely. This is not always accomplished by following the recommended formula with 1-ounce to 3-ounce dosages in flat-bottomed jars unless the cyanid used is in very small pieces and the jar is placed on edge.

Extensive research in chemistry has shown that an extra ounce of acid and 2 extra ounces of water added to the quantity required by the formula will give the needed amount of liquid and will in no way affect the liberation of gas in 1, 2, and 3 ounce dosages.

NATURE OF THE RESIDUE.

The residue from the generation of hydrocyanic-acid gas is very poisonous and usually is in the form of a bluish or greenish colored liquid consisting of water, sulphate of sodium, sulphuric acid, and hydrocyanic acid. Vegetation, such as cover crops, is destroyed by the action of this residue, and even surface roots of citrus trees in loose sandy soil are likely to be injured severely.

Some orchardists demand that the residue be carried off the field, but this precaution is unnecessary in ordinary fumigation where small dosages are used. The residue should never be emptied near the base of a tree, however, but midway between two rows previously fumigated. Care should be exercised that the tents do not come in contact with the residue.

THE MACHINE METHOD.

Recent developments in orchard fumigation have eliminated, to a large extent, the use of earthenware pots through the introduction of portable machines for generating the gas outside of the fumigating

tent. This development is especially interesting in that it is a return to the principle of generation followed by the late D. W. Coquillett in 1886, when he discovered the efficacy of hydrocyanic-acid gas in the control of insect pests of citrus trees. Mr. Coquillett's procedure consisted in bringing the cyanid dissolved in water in contact with sulphuric acid in a vessel outside the tent, and conducting the resulting gas under the tent by means of a pipe. In 1889 this procedure gave way to the pot method described in foregoing pages.

The first fumigating machine (fig. 6) was introduced in 1912, and the other (fig. 7), which differs in important features from the former, in 1915. These machines were used very extensively during 1915, 1916, and 1917.

GENERATING THE GAS.

The cyanid solution used in both machines is made of high-grade sodium cyanid dissolved in water at the rate of 1 ounce of cyanid to 2 fluid ounces of water. The dissolved cyanid increases the volume of the solution approximately 25 per cent, and this increase must be considered in graduating the cyanid-measuring apparatus. Undiluted commercial sulphuric acid in measured quantities at the rate of 1¼ ounces of acid to each 2½ ounces of cyanid solution, is used in the machine shown in figure 6. The machine shown in figure 7 differs in principle from that shown in figure 6 in that small amounts of cyanid solution are added successively to a large amount of dilute sulphuric acid until the latter is nearly exhausted.

THE INITIAL DOSE.

The generating cylinder of a fumigation machine, before starting work, contains a large amount of air which must be displaced before the full charge of cyanid gas is available. Mr. H. D. Young, of the University of California, states that two charges are required to expel all the air, and recommends that 4 ounces of cyanid be added to the first charge and 2 ounces to the second to meet this condition. Examination of small trees fumigated by operators who used no additional material with the first charges has shown much poorer results on the first row than on the succeeding ones.

DISSOLVING THE CYANID.

A heavy sheet-steel or sheet-iron tank is used for dissolving cyanid, which should be suspended near the top of the tank, as cyanid in solution is heavier than water. The cyanid purchased in 200-pound containers is dissolved readily by cutting numerous slashes along the lower edge and in the bottom and then suspending it in a tank con-

taining 50 gallons of water. Cyanid solution deteriorates materially when exposed to direct sunlight, but when it is kept covered in a cool place no deterioration takes place if allowed to stand from a week to 10 days. Before the machines are loaded cyanid solution should be stirred thoroughly to insure uniformity. Determinations made by the Bureau of Chemistry of this department show that cyanid solution of the concentration of 1 ounce of commercial sodium cyanid to 2 ounces of water will crystallize at a temperature approximating 40° F.; in fact, one instance of crystallization at a low temperature in commercial work was observed in December, 1915. It would appear inadvisable, therefore, to use a cyanid solution at a temperature below that at which crystallization takes place.

RESULTS WITH MACHINE FUMIGATION.

Horticultural commissioners, fumigators, and orchardists largely agree that the general results in scale-insect destruction are as satisfactory with the machine method as with the pot system. An investigation of gas generation with the machine shown in figure 7 showed that the average yield of gas with this machine approximates the amount evolved in pot generation.[1] It has been assumed that the amount of gas generated in the machine shown in figure 6 approximates that evolved by the pot method, since the proportion of chemicals used is the same in both cases. Although no investigation of the gas yield of this machine has been published, results reported in field work appear to corroborate this assumption. The most serious drawback of this machine appears to have been its defective construction. Nonuniformity of results in certain orchards fumigated with the machine shown in figure 7 was reported in November, 1915, by Dr. A. G. Smith, horticultural inspector for Pasadena, Cal. A careful inspection of several groves showed that the results in the destruction of scales were decidedly inferior on the last few trees in each row treated. The addition of extra acid to the machine toward the end of each row is reported to have remedied this. That the commercial success of machine generation is assured is shown by the fact that the major part of citrus fumigation in California during the last season (1917) was performed under the machine method.

DOSAGE.

The same dosage schedules are used with machines as with pots (see pp. 17 and 18), and all general recommendations for procedure, avoidance of plant injury, and insect control are applicable for both pot and machine generation.

[1] University of California Agricultural Experiment Station Circular 139. 1915.

ADVANTAGES OF MACHINE GENERATION AS COMPARED WITH POT GENERATION.

The two principal advantages of the fumigating machines are the lessened amount of tent burning and the greater accuracy possible in measuring the chemicals. One man less is required on an outfit, pots are no longer necessary, and the chemicals of fumigation are handled more economically. Carrying the residue from the field eliminates possible tree and tent injury from this source, while the danger of poisoning or burning the operator is reduced greatly by the less direct handling of the chemicals. The rapid generation of gas allows a greater initial concentration than by the pot method, and tends toward greater effectiveness. Handling a machine is less strenuous to the operator. Considering all these advantages it is apparent that the generating machine now forms a permanent part of the equipment for orchard fumigation. The pot method is doubtless more economical and practical for the private owner who has only a few trees to be treated, and for the fumigation of house-lot trees and trees in terraced orchards inaccessible to a machine.

THE LIQUID HYDROCYANIC-ACID METHOD.

The value of liquid hydrocyanic acid for the control of citrus pests was first demonstrated to the orchardists of California in 1916 and since then has gained a limited adoption. Some very satisfactory results have been obtained and this method, after standardization, gives promise of wide usage in the control of insect pests infesting citrus trees.

Liquid hydrocyanic acid is condensed from the gas and is transported in iron drums to the groves. The method of application is extremely simple. Liquid hydrocyanic acid is carried in a small tank which is mounted on a platform with a pump. The liquid is first measured, drawn into the pump, and finally discharged through a small pipe fitted with a spray nozzle. Simplicity of handling, which does away with the necessity of bringing cyanid and sulphuric acid into the field, and the elimination of tent burning are advantages in favor of the new method.

FUMIGATION PROCEDURE.

DOSAGE SCHEDULES.[1]

The term "dosage" is used to indicate the amount of cyanid needed to destroy a particular insect, and varies with the size of the

[1] In previous writings the author has referred to high-grade sodium cyanid as being 126 to 130 per cent pure. An equal amount by weight of chemically pure sodium cyanid liberates 33 per cent more hydrocyanic-acid gas than does pure potassium cyanid; and as potassium cyanid was the chemical formerly used for generating hydrocyanic-acid gas, this was expressed by designating the pure sodium cyanid as 133 per cent. In this bulletin where sodium cyanid is mentioned as 96 to 99 per cent pure, or containing not less than 51.3 per cent of cyanogen, it is of the same strength as that termed in former writings "126 to 130 per cent pure." Likewise dosage schedule 1 for sodium cyanid 96 to 99 per cent pure, containing not less than 51.3 per cent of cyanogen, is the same schedule as that formerly termed "dosage schedule 1" for sodium cyanid 126 to 130 per cent pure.

tree. Since a definite amount of gas is generated from an ounce of cyanid, the dosage is indicated in ounces.

Several years of experimental work in California, during which thousands of trees have been treated for the control of different scale insects, have made it possible to calculate dosages for different-sized trees and to prepare tables in convenient form for rapid use in the field. (See fig. 8.) These dosages are based on actual results under practical field conditions, proper consideration being given to the important subject of leakage.

The dosage for a tree is determined by two measurements taken after the tree is covered with a tent. These are the distance in feet around the tent at a height of about 3 feet from the ground and the distance in feet over the top of the tent from ground to ground. The numbers indicating the size of the tree are arranged along the outer sides of the chart. The square in the chart, formed by the intersection of the lines running from the two numbers representing, respectively, the distance around and the distance over a tree, contains the dosage for a tree of this size. For example, if it is found that the distance over the tent is 30 feet and the distance around the tent is 42 feet, the intersection of the lines leading from these numbers indicates that 10 ounces of sodium cyanid is the amount required by a tree of that size with dosage schedule No. 1 (see fig. 8). Using

DISTANCE AROUND, IN FEET.

DISTANCE OVER, IN FEET.	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
10	2	2	2	2	2																							10
12	2	2	3	3	3	3																						12
14	3	3	3	3	3	3	4	4	4	4	4	5																14
16	3	3	3	3	4	4	4	4	4	5	5	5	5	5														16
18	3	3	3	4	4	4	5	5	5	5	5	5	5	6														18
			20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
20			3	4	4	5	5	5	5	5	5	6	6	6	7	7	8	8										20
22					5	5	5	5	5	5	6	6	7	7	8	8	8	8										22
24						5	5	5	6	6	6	7	8	8	8	8	9	9										24
26							5	6	6	7	7	8	8	8	8	9	10	10	10	11	11	11						26
28								6	7	8	8	8	8	9	9	10	11	11	11	11	12	12						28
								30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
30								7	8	8	8	9	9	10	10	11	11	11	11	12	13	14	14	14	15	16	16	30
32											9	10	10	11	11	12	12	12	13	13	14	14	14	15	16	16	17	32
34											10	11	11	12	13	13	14	14	14	14	15	16	16	17	17	17	17	34
36											11	11	12	13	13	14	14	15	15	16	17	17	17	17	18	19	19	36
38												12	12	13	14	14	15	16	16	17	17	17	18	18	19	20	20	38
													40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
40												12	13	14	14	15	15	16	17	17	18	18	19	20	20	20	40	
41													14	14	15	15	16	17	17	18	18	19	20	20	20	21	41	
42														15	15	16	17	17	18	19	19	20	20	20	21	21	42	
43															16	17	17	17	19	19	20	20	20	20	21	22	43	
44																		17	17	19	20	20	20	20	21	22	22	44
																		50	52	54	56	58	60	62	64	66	68	
45																		17	19	20	20	20	20	21	22	23	23	45
46																		18	20	20	20	20	21	22	22	23	23	46
47																		18	20	20	20	21	22	22	23	23	24	47
48																		19	20	20	21	22	22	23	23	24	24	48
49																		19	20	21	21	22	23	23	23	24	25	49

FIG. 8.—Dosage schedule No. 1, for sodium cyanid 96–99 per cent (containing not less than 51.3 per cent cyanogen). Dosages are in ounces.

the 1–1½–2 formula for sodium cyanid, 15 ounces of sulphuric acid and 20 ounces of water would be required for this charge.

Experience has proved that for the most part citrus scale-insect pests do not require as strong a dosage for their destruction as is given in schedule No. 1. A schedule of dosages (fig. 9) three-fourths as strong as those in schedule No. 1 has, therefore, a broader usage. Weaker schedules, as one-half, one-third, etc., can be prepared if needed.

HOW TO MEASURE THE TREES.

As was stated in the preceding section, the dosage for a tented tree is based on the distance over the top and the distance around the bottom. The distance over the top of a tree is measured easily with a tapeline, but a much better and quicker method is to mark the tent as described previously. When such a marked tent is centered over a tree, the distance over the top is obtained by adding the two numbers that show where the line over the top of the tree touches the ground on opposite sides.

In tenting trees, especially small ones, the center of the tent frequently will fall to one side of the center of the tree, and in such instances one of the auxiliary lines is used. To avoid confusion, the center line should be heavier than the other two. The distance around the tent is taken by means of a tapeline, and can be measured by one man if the tape be provided with a catch for attachment to

DISTANCE AROUND, IN FEET.

DISTANCE OVER, IN FEET	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
10	2	2	2	2	2																							10
12	2	2	3	3	3	3																						12
14	3	3	3	3	3	3	3	3	3	3	3	4																14
16	3	3	3	3	3	3	3	3	3	4	4	4	4	4														16
18	3	3	3	3	3	3	4	4	4	4	4	4	4	5														18
			20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
20			3	3	3	4	4	4	4	4	4	5	5	5	5	5	6	6										20
22					4	4	4	4	4	4	5	5	5	5	6	6	6	6										22
24						4	4	4	5	5	5	5	6	6	6	6	7	7										24
26							4	5	5	5	5	6	6	6	6	7	8	8	8	8	8	8						26
28								5	5	6	6	6	6	7	7	8	8	8	8	8	9	9						28
								30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
30								5	6	6	6	7	7	8	8	8	8	8	8	9	10	11	11	11	11	12	12	30
32											7	8	8	8	8	9	9	9	10	10	11	11	11	11	12	12	13	32
34												8	8	8	9	10	10	11	11	11	11	11	12	12	13	13	13	34
36												8	8	9	10	10	11	11	11	11	12	13	13	13	13	14	14	36
38													9	9	10	11	11	11	12	12	13	13	13	14	14	14	15	38
													40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	
40													9	10	11	11	11	11	12	13	13	14	14	14	15	15	15	40
41														11	11	11	11	12	13	13	14	14	14	15	15	15	16	41
42															11	11	12	13	13	14	14	14	15	15	15	16	16	42
43																12	13	13	14	14	14	15	15	15	15	16	17	43
44																		13	14	14	14	15	15	15	16	17	17	44
																		50	52	54	56	58	60	62	64	66	68	
45																		13	14	14	15	15	15	16	17	17	17	45
46																		14	14	15	15	15	16	17	17	17	17	46
47																		14	14	15	15	16	17	17	17	17	18	47
48																		14	15	15	16	17	17	17	17	18	18	48
49																		14	15	16	16	17	17	17	17	18	19	49

Fig. 9.—Dosage schedule No. 3/4, for sodium cyanid 96–99 per cent (containing not less than 51.3 per cent cyanogen). Dosages are in ounces.

the tent. This measurement should be taken about 3 feet above the ground. *Never guess the distance around by pacing.*

HOW TO COVER THE TREES.

Commercial fumigators usually require that the soil in the orchard shall have been cultivated recently, so that it will be loose and level before the work of fumigation is begun, thus permitting the tents to lie smooth and close to the ground. One tent is then spread on the ground on the side of each tree, in the first row to be treated, farthest from the center of the orchard.

For covering trees up to 18 or 20 feet in height, two poles of the character described on page 7 are required, one for each side of the tree. Preferably the poles should be about a foot longer than the height of the trees. If rings are attached to the tents the ends of the poles are inserted into the rings. It is very much easier, however, not to use rings on tents manipulated by poles, but to double-lap the edge of the tent over the end of the pole and attach it by a half hitch of the pulling rope. (Fig. 10.) This is done quickly, does not subject the tent to undue wear, prevents detachment, which sometimes occurs with rings, and allows the distance between the poles to be varied in accordance with the width of the tree. *To prevent the seams from pulling apart, the tent always should be moved in the direction in which the strips run.*

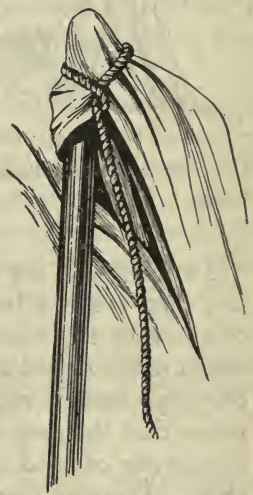
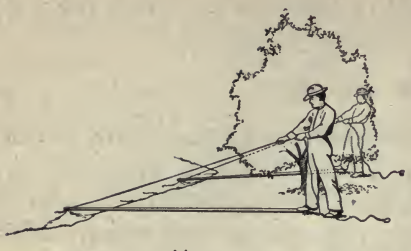


FIG. 10.—Method of attaching tent to hoisting pole by a half hitch of the rope.

The successive stages in covering a tree are shown in figures 11 to 14. The tent should be held taut between the ends of the poles to prevent it from catching in the top of the tree by sagging. When the covering is completed the poles are detached and carried to the next tree to be covered.

Great care should be exercised in covering large trees to avoid overpulling the tent. The bottom of the tent should be kicked in and, at the same time, examined to see that it lies close to the ground the entire distance around the tree. Where possible, it is much easier to transfer a tent from tree to tree without pulling it to the ground. The poles should be attached to the edge of the tent, then raised and leaned against the tented tree. The remaining steps are the same as those previously explained.

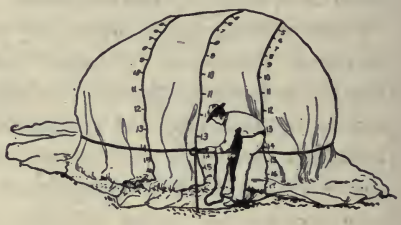
To cover very large trees derricks such as are described on pages 7 and 8 should be used. Four men are required for their manipulation. (See figs. 15–17)



11.

12.

13.



14.

FIGS. 11–14.—Successive stages in placing a tent over a tree with poles.

OPERATION OF AN OUTFIT.

To operate a set of 30 tents to advantage under the pot system five men are required; two to pull the tents and kick in the edges, one to take the measurements and determine the dosage, and two to measure the chemicals and dose the trees. Under the machine method only one man is required to handle the chemicals. Care should be taken that the pots are placed well inward from the tent, so that any spattering of acid during the generation of gas will not reach the cloth. The man handling the acid should never touch the tents.

Outfits employing 40 to 60 tents usually employ six or seven men. In this case four men are employed as tent pullers and the others as previously explained.

CARE OF TENTS.

One of the greatest necessities, and at the same time the one most likely to escape notice, is the proper repairing of fumigation tents. If acid comes in contact with a tent, a hole is certain to be the result, and even with very careful operators acid holes are occurring constantly. These become very numerous if not attended to, and permit leakage of gas. Moreover, tears in tents are of frequent occurrence.

Every large outfit should employ a man whose sole duty is to overhaul tents and keep them in the best possible state of repair. This man should be supplied with a sewing machine adapted to tent

mending. Tents are best patched by sewing pieces of canvas over the holes, rather than by trying to draw holes together with threads. Patches stuck by rubber tissue are temporarily satisfactory, but are not lasting, and for this reason are inferior to those machine-sewed. In the daytime tents should be spread out to dry.

NECESSITY FOR CAREFUL WORKERS.

Unsatisfactory fumigation is frequently the direct result of carelessness, and for fumigating an orchard it is of primary importance to have careful, conscientious men. It is very easy for a careless scheduler to form the habit of guessing rather than measuring the dosages of trees, for the careless man with the supply wagon to make unnecessary mistakes in weighing the chemicals, and for the tent pullers not to kick in the skirts of the tent or pull down the sides which do not touch the ground. Carelessness or neglect in any one of these particulars will influence the results unfavorably.

Since fumigation is carried on only at night and for a short season, it frequently is difficult to secure desirable labor. Experience has proved that the best work is done where regular employees are transferred temporarily from other duties to assist in fumigation, and for this reason the orchardist, if possible, should have his field employees fumigate his trees. Citrus associations possessing outfits should transfer careful men from their packing houses or field crews.

Where there are several fumigation outfits operating in a community, it is urged strongly that a competent, well-trained man be employed at a regular salary to have personal charge of all control work with insecticides.

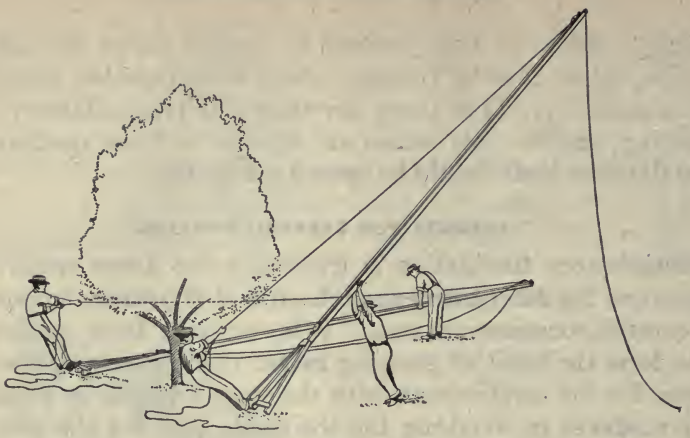
GENERAL CAUTIONS.

Hydrocyanic-acid gas is one of the most deadly gases known. Therefore precautions in its use are essential. The careful fumigator who avoids being subjected to strong fumes, however, runs no risk. In California men work around tented trees where they breathe diluted gas every night for several consecutive weeks without feeling any ill effects aside from an occasional dizziness or headache. Cyanid should be kept in containers tightly locked while not in use.

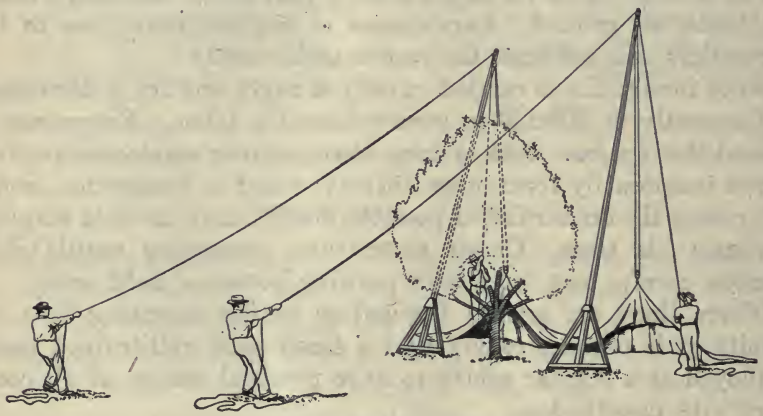
Hydrocyanic-acid gas is inflammable, and care should be exercised not to permit the concentrated gas as it rises from the generator to come in contact with fire; diluted gas is not inflammable.

EFFECT OF THE GAS ON THE PLANT.

Hydrocyanic-acid gas is fatal to insects when the dose is sufficiently large and the exposure long enough, but a much greater strength of gas is necessary for the destruction of some insects than for others. Were it not for the destructive action of the gas on the plants, its field of usefulness would be increased greatly. Since different species



15.



16.

17.

FIGS. 15–17.—Successive stages in placing a tent over a tree by means of derricks.

and varieties of plants vary remarkably in their power to withstand the poison, however, it is necessary in fumigating with this gas to take into consideration the particular plants to be fumigated and their susceptibility to gas injury.

The foliage and branches of orange, lemon, and grapefruit trees will stand without severe injury a strength of gas sufficient to destroy most of the scale insects which infest them. Apple, peach, pear, and other deciduous trees in dormant condition can be fumigated without injury with a strength of gas greater than it would be advisable to use on citrus fruit trees.

It is impossible to fumigate a citrus tree effectively without burning back for a few inches many of the tenderest shoots. Slight burning of the foliage, however, is not considered injurious to the trees. The injury to be avoided is the burning and pitting of fruit, and this frequently occurs unless great care is exercised.

The action of hydrocyanic-acid gas on the plant cells is the cause of fruit burning as well as foliage injury in fumigation. Numerous factors, explained later, serve to intensify the injury, but these factors are distinct from the main cause.

The tenderest shoots of plants are the ones most easily injured by this gas. It is well known that a very heavy dosage in field fumigation will not only pit full-grown fruit, but even destroy the old resistant foliage. Plants in dormant condition are more resistant to gas than are those in their period of growth. When fruit is small and tender it is easily pitted by a moderate strength of gas, whereas the same concentration applied when the fruit has matured may produce no injury at all. The epidermis and the cells immediately beneath in immature fruit seem to be much more susceptible to injury from gas penetration than those in mature fruit.

GAS INJURY THROUGH ABRASION OR PUNCTURING OF THE SKIN OF FRUIT.

It is of common occurrence to see injured fruit in the very tops of fumigated trees. When both tents and fruit are dry severe injury is infrequent, but should either or both become very wet severe injury might follow. Especially is this true after fumigation in damp weather on loose, sandy soil. Damp tents collect sand and, when drawn over the trees, scrape the fruit, causing abrasions of the epidermis. Once the epidermis is abrased and the cells beneath exposed, the absorption of the gas apparently intensifies the injury, which spreads and usually results in the collapse of a considerable area of skin. These spots are called pits or burns and do not show for from one to three days after fumigation.

Where trees are fumigated under ideal conditions and some fruit is pitted, a close inspection will reveal that many of these pits are in

places where the fruit has been abrased by contact with tents, poles, branches of the tree, or other fruit. If the poles are placed well in toward the tree so that they scrape or throw about branches or fruit in covering, abrased fruit sometimes results, especially in damp weather. The tents weigh down the branches and move them more or less severely during the covering of a tree. Where fruit comes sharply in contact with the ragged edge of a branch abrasion of skin is likely to follow. A heavy wind which beats the branches about will also cause much abrasion. Moist weather intensifies this condition. Sometimes, in separating fruit on a cluster after fumigation, pits are found at points of contact. This might be due to weakness of the epidermis, the result of one fruit brushing against another, or insect attack, which is frequently localized in such protected places. In certain cases insects which frequent citrus trees unquestionably play an important part in pitting. Fruit injured by fumigation has been seen which, at the time of treatment, was severely infested with mites, or red spiders.

Unless the skin has been abrased or weakened shortly before the treatment, well-grown fruit on healthy citrus trees is seldom injured by the average dosage applied under proper weather conditions.

CONDITIONS OF WEATHER DURING WHICH GAS INJURY IS LIKELY TO RESULT.

Unfavorable weather conditions at the time of fumigation are often responsible for injury to trees and fruit. In the following paragraphs various meteorological elements are discussed briefly.

LIGHT.

Fumigation should be carried on only at night. By careful treatment in cool, cloudy weather it is possible to fumigate trees in the daytime without serious injury, provided the dose is weak, but this practice is not followed in this country. Long periods of cool, cloudy days seldom occur during the regular fumigation season, and past attempts by some fumigators to practice daylight fumigation generally have resulted in such severe injury that the practice has been rightly discontinued.

The actinic rays of light intensify plant injury, both during and immediately after fumigation. Plants fumigated in direct sunshine, or placed in direct sunshine within one or two hours after treatment, usually are injured, the degree of injury depending upon the strength of gas used and the temperature of the air. Plants fumigated in diffused light appear to be no more injured than those fumigated in darkness.

Trees of the first row fumigated at night and those of the last row fumigated in the morning frequently are more or less injured. In the former case the injury is due to the fact that operations were

begun before the sun had set; in the latter case, to the fact that the operations were continued after sunrise. The injury described above is more apparent in the summer than in the cool days of late autumn.

TEMPERATURE.

Heat.—Heat apparently increases the poisonous properties of hydrocyanic-acid gas, and instances of severe injury directly attributable to high temperatures have occurred during commercial fumigation. Very little injury results from heat alone at a temperature as high as 70° Fahrenheit with the use of schedule No. 1, but *it is well to hold this temperature as a maximum* unless the orchardist is willing to assume risks. Where much weaker dosages are used, it is possible to fumigate at a higher temperature without severe injury, though the risk is great. In a case such as that of the citricola scale, an insect susceptible to fumigation only in its immature stages, which occur during the hot summer months, it frequently is advisable to treat even at temperatures in excess of the degree of perfect safety.

Cold.—Experience has shown that fumigating trees at a temperature near the freezing point often results in severe injury. In some instances treatment has been carried on with impunity at a freezing temperature, where light dosages were used, but the risk is too great to justify such treatment of citrus fruit trees. It is recommended that fumigation be discontinued when the temperature drops to 38° Fahrenheit.

WINDS.

Fumigation should never be attempted during a heavy wind for two reasons: First, the gas is blown out of the tent, so that poor work results; second, injury to trees may occur. The burning of fruit during heavy winds has been observed frequently. It has been explained previously that hydrocyanic-acid gas in contact with skin abrasions of citrus fruits usually produces pits, and this is undoubtedly the explanation of fruit injury while fumigating during heavy winds which beat about the tents and fruit-laden branches, thereby abrasing the fruit while exposed to the gas. A safe guide to follow is to discontinue fumigation as soon as the wind is sufficiently strong to cause the tents to flap. In California there are winds called locally "Santa Ana," or "electric," which are the result of storms in the surrounding desert, and fumigation during these periods is especially to be avoided, as they are accompanied usually by high temperatures.

MOISTURE.

Although hydrocyanic-acid gas in the presence of water readily passes into solution, it has been proved definitely that the presence

of water alone on citrus trees is in no way responsible for burning by possible absorption of gas.

There are other reasons of an indirect and largely mechanical nature, however, which necessitate the consideration of moisture. (1) The presence of moisture increases the weight of the tents, rendering them more difficult to handle, which results in much injury to fruit and branches. (2) On light, sandy soil, damp tents collect much dirt and injure fruit by scraping when being pulled over trees. (3) Moisture affects the fiber of the cloth, rendering it more impervious to gas. Therefore in fumigating large trees on a damp night more gas accumulates in the tops of the tents than is normally the case. This intense strength of gas sometimes causes pitting, especially with varieties least resistant to hydrocyanic-acid gas.

Doubtless the chief cause of fruit injury is the action of hydrocyanic-acid gas on skin abrasions produced by covering the tree with wet, heavy tents. Entire rows of trees have been seen in which fully half of the fruit had been rendered worthless from severe gas burning at tent-scraped surfaces. Considering the disadvantages and resultant injury in the use of wet tents, it is evident that fumigation should be discontinued as soon as the leaves and fruit become thoroughly moist. The presence of moisture on trees does not appear to reduce the efficacy of hydrocyanic-acid gas against scale insects.

EFFECTS OF FUMIGATION ON UNHEALTHY TREES.

Occasionally a part or all of an orchard is composed of trees weakened by lack of such essential treatments as proper cultivation, fertilization, or irrigation. Many orchards contain trees weakened by attacks of gum disease, scale insects, gophers, and numerous other agents which check their normal development. These unhealthy trees are more susceptible to injury from fumigation than are perfectly healthy ones, and a dosage which in no way would affect a perfectly healthy plant is likely to cause pitting of fruit and shedding of leaves. If this injury is confined to unhealthy trees there is no occasion for alarm, as usually the fruit on such trees is of an inferior grade. Unhealthy leaves would not remain on trees in this condition much longer, and the hastening of their removal is soon followed by a fresh, invigorated growth which in all respects is superior to the old.

INFLUENCE OF SOIL CONDITIONS ON FUMIGATION.

Where the cultivation or irrigation of citrus trees does not receive proper attention during the hot, dry months, as sometimes happens, the soil may become dry and hard, and possibly the plants may suffer from lack of necessary moisture. The question frequently arises as

to the danger of injury in fumigating such trees. In all probability citrus trees fumigated while suffering a *slight* lack of moisture will not show any more injury than those fumigated where necessary moisture is present. Trees allowed to suffer from long-continued lack of moisture, however, become weak and unhealthy, and their treatment with hydrocyanic-acid gas frequently results in severe injury, as would be the case even if such unhealthy trees were under the most ideal moisture conditions at the time of fumigation.

Fumigation with dry tents after a heavy rain when the soil is wet does not appear to affect citrus trees adversely. It is inadvisable, however, to continue field operations on wet soils, more especially wet, sandy soils, as the tents themselves will soon become wet, heavy, and soil-covered, and when in this condition, as explained under "Moisture" (p. 26), they can not be used without danger of injury to the fruit and branches.

STRENGTH OF GAS CITRUS TREES WILL STAND WITHOUT INJURY.

The lemon tree is much more resistant to injury from fumigation than is the orange or grapefruit and seldom suffers appreciable damage when treated under normal conditions with either schedule No. ¾ or schedule No. 1. Some varieties of oranges are injured more easily than others. Of the varieties of commercial importance in California, the Navel and Valencia are the least susceptible to injury from gas treatment. The seedling is almost equally hardy, while the tangerine (mandarin) stands the gas quite well. The Mediterranean Sweet is not quite so resistant to the gas as are the preceding varieties, and the Homosassa and St. Michael are easily injured by fumigation. It is inviting damage to fumigate the last two varieties with schedule No. 1, and injury might result with schedule No. ¾ unless prevailing conditions were favorable. Fortunately, the Navel, the Valencia, and seedlings comprise the bulk of the oranges grown in this State.

In general a strength of gas up to schedule No. ¾ can be used on citrus trees with a minimum amount of injury if care be exercised, although with schedule No. 1 more pitting is to be expected. Unless it is desired to eradicate a resistant pest on a few badly-infested trees, doses exceeding those in schedule No. 1 should not be used while fruit is present, except during the winter, when citrus trees are more or less dormant and the fruit is resistant to gas injury.

As fruit on the tree matures its resistance to gas injury increases. Fruit in transport or in storage appears to be more resistant to gas injury than fruit on the tree.

FUMIGATION INJURY TO SPRAYED TREES.

Orange trees frequently are sprayed for the control of certain insect pests or plant diseases. The sprays in common use are Bordeaux mixture, lime-sulphur solution, and petroleum oils. If trees are fumigated after the application of Bordeaux mixture, injury will result, especially during damp weather. In severe cases all the leaves will fall and much fruit will be spotted. Injury is known to have appeared fully six months after the spraying. Furthermore, fumigation has been observed seriously to injure trees the trunk and branches of which had been painted previously with Bordeaux paste, although the paste did not touch the fruit or foliage. Very little complaint has resulted from the fumigation of trees where the trunks alone received Bordeaux application.

Trees previously treated with an oil or sulphur spray can be fumigated without injury other than that which might occur on unsprayed trees. If the trees are *weakened* by the use of oil sprays, however, fumigation may cause leaf-drop.

FUMIGATION OF TREES IN BLOOM.

Trees may be fumigated while in bloom without unusual injury.

CITRUS INSECTS AND THEIR CONTROL.

CITRUS PESTS AGAINST WHICH ORCHARD FUMIGATION MAY BE PRACTICED.

Fumigation with hydrocyanic-acid gas is especially adapted to the control of scale insects and white flies, which live a part or all of their existence attached to the plants, and, as practiced at the present time, orchard fumigation is confined almost exclusively to the control of this class of insects on citrus fruit trees.

DIRECTIONS FOR CONTROLLING VARIOUS CITRUS PESTS.

Much experimental work with fumigation against various citrus pests in California and Florida has resulted in definite records of the successful control of these insects. Specific information on the control of the common insect pests of citrus trees in this country is given in Table I. Insects such as the white flies and armored scales, which can be destroyed in practically all stages of development, can be fumigated at any time the trees are in a condition best fitted to resist injury. In general, soft or unarmored scales are very resistant to hydrocyanic-acid gas in the mature and egg stages; it is advisable, therefore, to fumigate these pests during their breeding season while the insects are in the immature stages.

TABLE I.—*Control of citrus-fruit insect pests by fumigation with hydrocyanic-acid gas.*

Insect.	Dosage and exposure.		Season for treatment.	
	Schedule No.	Time.	In California.	In Florida.
California red scale (*Chrysomphalus aurantii* Mask.)	2	45 minutes [1]	August to April	
California yellow scale (*Chrysomphalus citrinus* Coq.)	2	do	do	
Purple scale (*Lepidosaphes beckii* Newm.)	2	1 hour	do	December to February
Glover's scale (*Lepidosaphes gloverii* Pack.)	2	do	do	Do.
Florida red scale (*Chrysomphalus aonidum* L.)	2	45 minutes		Do.
Black scale (*Saissetia oleae* Bern.):				
Immature insects	2	do	August to December	
Mature insects	1	1 hour	do	
Citricola scale (*Coccus citricola* Camp.)	2	45 minutes	July to September	
Citrus white fly (*Dialeurodes citri* Ashm.)	2	do		Do.
Cloudy-winged white fly (*Dialeurodes citrifolii* Morg.)	2	do		Do.

[1] At Corona, Riverside County, this insect appears to be more resistant to hydrocyanic-acid gas than elsewhere in California. A stronger dosage than that indicated in the table is required in this region.

LENGTH OF EXPOSURE.

In fumigation with untreated cloth tents practically all of the gas escapes before the expiration of one hour, unless the weather is very damp. Experience in orchard fumigation has shown that an exposure of 45 minutes for most insects gives practically as good results as that of an hour. Where eggs are present, the one-hour exposure results in slightly more effective work.

TIME OF YEAR FOR FUMIGATION.

Many of the scale insects can be destroyed easily by fumigation at any stage of development. These insects may be fumigated at any time of the year, and include such species as the red, yellow, and purple scales. Other scale insects are very resistant to treatment in the egg and adult stages. This type of insect, which includes such species as the black, hemispherical, and soft brown scales, must be treated in the early stages of development, when they are least resistant to the gas.

Unfortunately citrus trees are not in a condition to resist gas injury equally well at all times of the year, and care must be used to see that fumigation is carried on under the most favorable weather conditions and when the fruit is of fair size. It is preferable, of course, to fumigate after the fruit has been picked, but this is seldom possible in California. The most suitable season for orchard treatment in California is from the 1st of August to the middle of December; in the Gulf Coast States, from the 1st of December to the last of February.

REMOVAL OF OLD SCALY FRUIT.

Scale insects on fruit are usually more difficult to destroy than those on the leaves or branches. Especially is this true for an egg-laying species such as the purple scale. When fruit is picked, a few old scaly oranges are occasionally left on the trees. Such fruit should be removed before fumigation, lest it become a source of reinfestation after the other parts of the tree have been cleaned.

SUCCESSIVE TREATMENTS.

As stated, some scale insects are very resistant to fumigation in the egg and adult stages, though easily destroyed in the immature stages. Occasionally plants which will not stand a high concentration of gas are infested with all stages of scale insects, and if the eggs and adults are very resistant it is possible to control the pest through the destruction of the immature insects by using a concentration of gas which will not injure the plants. In such cases successive fumigations are necessary; the first will destroy all the immature insects present at the time of treatment, and fumigations repeated at the necessary intervals will destroy all the insects hatching since the preceding fumigation. This work necessitates a knowledge of the life history of the insect concerned.

COST OF FUMIGATION.

The cost of fumigating an orchard depends primarily on the size of the trees and the dosage rate used. The average citrus orchard in California, where fumigation is practiced, requires an expenditure of from $25 to $40 per acre for one treatment. Large seedling trees are more expensive, while young trees cost considerably less. Estimates given by contract fumigators usually are based on the cost of the two factors, chemicals and tree covering. The present cost of chemicals approximates 30 cents a pound. In commercial work the average price for covering with tents 45 feet or less in diameter is from 10 to 12 cents per tree. The cost of thirty 45-foot tents of special 8-ounce fumigating duck, together with the other equipment necessary to complete the outfit, will approximate $1,500.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO INSECTS INJURIOUS TO CITRUS AND OTHER SUBTROPICAL FRUITS.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

Control of the Citrus Thrips in California and Arizona. (Farmers' Bulletin 674.)

Carbon Disulphid as an Insecticide. (Farmers' Bulletin 799.)

Common Mealybug and its Control in California. (Farmers' Bulletin 862.)

Fumigation of Ornamental Greenhouse Plants with Hydrocyanic-acid Gas. (Farmers' Bulletin 880.)

Control of the Argentine Ant in Orange Groves. (Farmers' Bulletin 928.)

Citrus Fruit Insects in Mediterranean Countries. (Department Bulletin 134.)

The Mediterranean Fruit Fly in Bermuda. (Department Bulletin 161.)

Katydids Injurious to Oranges in California. (Department Bulletin 256.)

Argentine Ant: Distribution and Control in the United States. (Department Bulletin 377.)

The Melon Fly in Hawaii. (Department Bulletin 491.)

Fumigation of Ornamental Greenhouse Plants with Hydrocyanic-acid Gas. (Department Bulletin 513.)

The Citrus Thrips. (Department Bulletin 616.)

The Mediterranean Fruit Fly. (Department Bulletin 640.)

The Melon Fly. (Department Bulletin 643.)

Some Reasons for Spraying to Control Insect and Mite Enemies of Citrus Trees in Florida. (Department Bulletin 645.)

The Argentine Ant in Relation to Citrus Orchards. (Department Bulletin 647.)

Preparations for Winter Fumigation for Citrus White Fly. (Entomology Circular 111.)

Spraying for White Flies in Florida. (Entomology Circular 168.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

The Mediterranean Fruit Fly in Hawaii. (Department Bulletin 536.) Price, 30 cents.

Mango Weevil. (Entomology Circular 141.) 1911. Price, 5 cents.

Fumigation for Citrus White Fly, as Adapted to Florida Conditions. (Entomology Bulletin 76.) 1908. Price, 15 cents.

Fumigation Investigations in California. (Entomology Bulletin 79.) 1909. Price, 15 cents.

Hydrocyanic-acid Gas Fumigation in California. (Entomology Bulletin 90, 3 pts.) 1913. Price, 20 cents.

Fumigation of Citrus Trees. (Entomology Bulletin 90, Pt. I.) 1913. Price, 20 cents.

Value of Sodium Cyanid for Fumigation Purposes. (Entomology Bulletin 90, Pt. II.) 1913. Price, 5 cents.

Chemistry of Fumigation with Hydrocyanic-acid Gas. (Entomology Bulletin 90, Pt. III.) 1913. Price, 5 cents.

White Flies Injurious to Citrus in Florida. (Entomology Bulletin 92.) 1911. Price, 25 cents.

Orange Thrips, Report of Progress. (Entomology Bulletin 99, Pt. I.) 1911. Price, 5 cents.

Red-banded Thrips. (Entomology Bulletin 99, Pt. II.) 1912. Price, 5 cents.

Natural Control of White Flies in Florida. (Entomology Bulletin 102.) 1912. Price, 20 cents.

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A SIMPLE WAY TO INCREASE CROP YIELDS

Methods Followed by Farmers of the Coastal Plain Section of the Central Atlantic States in Building Up Soil Fertility

H. A. MILLER
Agriculturist

FARMERS' BULLETIN 924

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF THE SECRETARY
Contribution from the Office of Farm Management
W. J. SPILLMAN, Chief

Washington, D. C. February, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

THE SOILS of the coastal plain section of the Central Atlantic States, as a rule, are light in character, have been farmed for generations, and need first of all a liberal supply of organic matter. This need should be met by growing such legumes as crimson clover, cowpeas, soy beans, red clover, and hairy vetch. Rye, buckwheat, and the grasses are also valuable in this connection.

Commercial fertilizer and lime should be used freely when necessary to stimulate the growth of these soil-improving crops.

By arranging the cropping system to include one or more legumes that supply the land with nitrogen and humus, crop yields have been greatly increased on many farms scattered throughout this region. The systems followed on a few of the more successful of these farms are described in detail in the following pages.

A SIMPLE WAY TO INCREASE CROP YIELDS.

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THE COASTAL PLAIN section of New Jersey, Maryland, Delaware, and Virginia constitutes one of the oldest farming regions in the Central Atlantic States. Much of the cleared land has been farmed continuously since the region was settled more than two hundred years ago. As a rule, the cropping systems and methods of farming of the past have not provided for maintaining fertility, and in some localities a relatively large part of the farm lands do not produce yields large enough to make farming profitable. During more recent years, however, more attention has been given to the improvement of the farm lands of this region, and as a result much of the soil has been built up in fertility and many farms are now producing more than double the crop yields they did before.

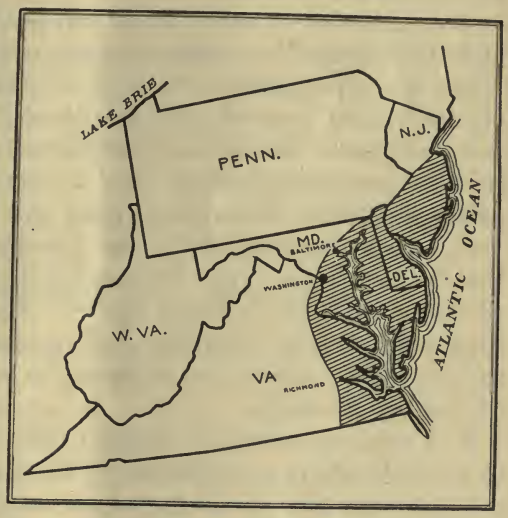

FIG. 1.—Map of Coastal Plain section of central Atlantic States.

ECONOMIC CONDITIONS.

The coastal plain section of the Central Atlantic States is especially well located geographically with reference to several of the important centers of population that consume large quantities of farm products. A market is therefore within easy shipping distance

for the great variety of crop and live-stock products to which the conditions of climate and soil of this region are so well adapted.

Transportation is provided by both rail and water. In a large part of the region railroads, and in many cases the main lines, connect directly with the large cities, which permits the marketing of the most perishable products without difficulty. Chesapeake Bay and its tributaries, which in many instances are navigable some distance inland, afford water transportation to those parts of the region not reached by railroad.

The farm land of this region is made up of a great variety of soils, varying from sands and sandy loams with light subsoil to silts and silt loams and clay loams with heavier subsoils. The natural productiveness of these soils varies greatly. Some need special treatment at the start in order to make them productive; others are productive for a few years, but are soon depleted unless provisions are made for the maintenance of fertility; while other classes of soil have been farmed continuously for a great many years and are still producing good crops.

This variation in character of soil in different parts of the region and the demand for different farm products by the cities have resulted in the production of a wide diversity of crops. Farms located on the lighter, sandier soils are devoted mostly to the growing of truck and small fruits, while the farms on the heavier land produce crops of corn, wheat, and hay, and live-stock products. The combined effect, therefore, of soil conditions and market demands has been very largely responsible for the development of types of farming that do not include much live stock, but go more into the production of cash crops for sale on the market. This development has resulted in the use of large quantities of commercial fertilizer, which, in a measure, has retarded the development of other important methods of soil maintenance.

As a rule, comparatively little attention in the past has been given to methods of soil management by the farmers of this region. Even now, in many localities, legumes are not generally grown and winter cover crops are practically unknown. In many cases the same crop has been grown year after year on the same land with little or no provision for maintaining fertility other than the use of small amounts of commercial fertilizer. This lack of attention on the part of the farmer has resulted in poor yields and an unproductive condition of the soil on many farms of the region.

At the present time, then, the situation with respect to crop production here may be stated as follows: The stronger and naturally more fertile soils are still producing profitable crops and will probably continue to do so for many years. Other soils that have been built up by improved methods of soil management to a high state of

fertility are also productive. By far the greater portion of the region, however, is returning crop yields that are responsible for placing many farms on the border line between a profitable and a losing business. There is also a considerable amount of land that is decidedly unproductive and some that for this reason is not farmed at all. Since crop yield is one of the more important single factors in determining the profits from farming, it is of the utmost importance to the agriculture of the region that the fertility of these poorer producing lands be improved.

The changes in economic conditions demand greater returns than ever. The cost of production has increased; farm labor is scarce and wages are high; equipment is expensive and the price of land has gone up. The price received for farm products until recently has not increased in the same proportion, so that low yields are distinctly unprofitable. Larger yields are therefore of the utmost importance in a large part of the coastal plain section of the Central Atlantic States. Most of this land can be made more productive by a moderate outlay of time and money if the proper methods of management are carried out. The first step toward the solution of the problem of these poor lands is perhaps the most difficult—the building up of soil fertility to a point where it will produce yields large enough to put farming on a paying basis. Fortunately, we have many examples of farms located in this region that have been made more productive by the farmers adopting improved methods of management that may well serve as a guide in the solution of the problem of building up soil fertility and obtaining better crop yields on other poor farms.

IMPORTANT FACTORS IN SOIL IMPROVEMENT.

On account of the differences in the character of the soil and the great variety of crops that are grown in this region, there is much diversity in farm practice, not only in the use of fertilizers and methods of tillage but also in the methods of soil improvement. For example, some farmers depend chiefly on the manure from live stock to make their land productive, others depend on the sod remaining from grass and clover crops with the use of commercial fertilizers, others grow legumes to turn under as green manure, while still others use a combination of one or more of these methods. There is one outstanding feature, however, in all of these different methods of building up land, the fact that in every case where the fertility of the soil has been built up and crop yields materially increased large quantities of vegetable matter have been added to the soil in one form or another.

Commercial fertilizers and tillage practices also play an important part in crop production, but the general results that have been obtained indicate that humus is one of the most important factors in

the improvement of the soil of this region and that crop production depends very largely upon the quantity of decayed vegetable matter present. On some of the poorer, low-yielding land, for example, a good growth of crimson clover turned under doubles the yield of the succeeding crops. There are many instances where farmers have plowed under three crops of crimson clover in succession and have brought the land up from a condition where it produced only 15 bushels of corn per acre to a point where it produced more than 50 bushels per acre. This indicates that as the organic matter is increased in these soils yields increase also.

The presence of organic matter benefits these lands in several ways. It increases the bacterial activity so essential to crop production. Water is absorbed more readily during heavy rains, which lessens the danger from washing. Soils well supplied with organic matter are also more retentive of moisture, remain more friable, are easier to work, and are less likely to become hard or form a crust after rains. The chief source of nitrogen in the soil is from the breaking down and decay of organic matter present. Since nitrogen is one of the most expensive fertilizers that the farmer has to buy, it is very important that every effort be made to supply this element by growing legumes or providing humus in other forms.

The big problem in connection with the improvement of farm land in this region is to get organic matter into the soil and to do it economically. In the farm practice of the region there are three principal sources from which humus is usually supplied—farm manure, roots and stubbles left from crops, and green crops turned under.

FARM MANURES.

Farm manure is a most valuable source of fertility on many of the farms of this region. In addition to supplying considerable nitrogen, some phosphoric acid, and potash, it is also an important source of humus. In parts of this region where the type of farming includes live stock, the manure from the animals and the sod remaining from the clover and grass crops are the chief reliance for maintaining the supply of organic matter in the soil. On the heavier soils, and especially on live-stock farms where a large part of the land is kept in sod, the manure produced is usually sufficient to maintain the organic matter necessary for good crop production. But on some of the lighter lands it is difficult to maintain the normal supply of organic matter even on farms heavily stocked with animals and where all crops are fed. On the lighter lands especially it is necessary not only to use all the available manure but still further to increase the organic matter in the soil by crop residues and green crops turned under.

The importance of supplementing the farm manure with organic matter from other sources is well illustrated by the results obtained on a dairy farm located on light sandy land in Anne Arundel County, Md. The crops grown were corn and cowpeas in a two-year rotation. Two hundred pounds of acid phosphate per acre were applied to each crop. In addition to the roughage produced by the corn and cowpeas, grain was bought and fed to the cows. In spite of the fact that all of the manure thus produced by the cows and work stock was returned to the land, the crop yield steadily declined until the cropping system was rearranged to provide a greater quantity of organic matter in the soil. This was accomplished by sowing crimson clover in the corn and plowing it under for the cowpeas.

FIG. 2.—Sixty bushels of corn per acre and a large amount of organic matter to be returned to the soil.

CROP RESIDUES.

The roots and stubble left in the soil after crops are harvested constitute a very important source of organic matter. The amount of this material left from such crops as corn and wheat when harvested in the usual way is not large, but where systems of management are followed which leave practically the entire crop on the field the organic matter thus added is very much greater. The practice of pasturing off crops with live stock is a very economical way of removing the crops and adding large quantities of organic matter to the soil. Figure 2 shows the possibilities of this method.

The corn crop shown in this illustration was husked from the stalk and live stock was turned in to pasture on the peas and cornstalks. This is a very effective method of building up soil through the addition of organic matter.

Supplying organic matter by methods which turn back as great a crop of residue as possible ordinarily does not receive sufficient attention on the average farm of the region. In planning a cropping system the amount of organic matter that will be supplied to the land should be carefully considered and every opportunity to increase this supply should be utilized. The cropping system that does not provide for maintaining an abundance of organic matter in the soil is of little value in building up fertility. Merely alternating crops is not sufficient. Hay and pasture land should be plowed while there is still a good sod. Weeds, cornstalks, straw, and other material of this kind are valuable sources of organic matter. In addition to this, the cropping system should provide either for the pasturing off of crops with live stock or the turning under of green crops regularly in the rotation.

IMPORTANT CROPS FOR SOIL IMPROVEMENT.

The type of farming usually followed in the coastal plain section does not include much live stock aside from the necessary work animals. As a result, there is very little manure available on the average farm, and crops grown for the purpose of supplying organic matter must be relied upon to keep the soil in a productive condition. Perhaps the most rapid progress in the improvement of depleted farm lands in this section is attributable to this method of procedure. Especially is this true where the farmers have made provision in their cropping systems to plow under some green crop at regular intervals. In some instances it has been necessary to produce several green manure crops and plow them under before sufficient organic matter could be accumulated to produce yields that would be at all profitable. This is somewhat expensive, but in extreme cases of soil depletion it is doubtless good practice.

In planning to use green-manure crops as a means of soil improvement it is of distinct advantage to use legumes in so far as possible. In addition to adding the organic matter, which is of so great importance, these crops supply large quantities of nitrogen to the soil. As has been pointed out, nitrogen is the most expensive element which is purchased in the form of commercial fertilizers. If legumes are grown regularly and plowed under on the different fields of the farm, the nitrogen required for the growth of the other crops will be supplied and much money may be saved which would otherwise have been expended on fertilizers.

COWPEAS.

Cowpeas are one of the best-known crops in the area and one of the first to be used for the purpose of soil improvement. This crop possesses several advantages over most others. It will probably grow on poorer soil and give better results in extreme cases of soil depletion than any other crop that is at present used in the

process of soil improvement in the area. It is advisable, generally, to begin building up the soil first by growing cowpeas, because this crop can be grown with very simple treatment and little expense in preparation. Cowpeas do well without lime or inoculation, and respond readily to the application of small amounts of fertilizer. (For full discussion of methods of growing cowpeas see Farmers' Bulletin 318.)

Cowpeas are grown in a number of ways and for a number of purposes, but however used they are valuable in the improvement of the soil. Occasionally the crop is plowed under, but it is more generally grown for hay. In some instances seed is produced and sold as a cash crop. Another plan which offers considerable opportunity for soil improvement is to sow cowpeas in the corn at the last cultivation. Grown in these various ways, cowpeas are capable of improving the land up to a point where a wider variation of crops can be produced.

CRIMSON CLOVER.

Throughout the region crimson clover stands out as one of the more valuable crops for soil improvement. In addition to being an excellent crop to plow under as a green manure, it is also valuable for early spring grazing and for hay. Sown in the late summer or early fall, it occupies the land during the winter and serves as a cover crop, and protects the soil from washing and leaching through the fall, winter, and spring seasons, which is a matter of very great importance in this region, where the winters are generally mild, with frequent rains. The expense of seeding is usually but little more than the cost of the seed, and many farmers are now growing their own seed.

Crimson clover can be grown in this section in several different ways. It may be seeded alone in August and September, or in the corn at the last cultivation. It is common practice also to sow it in July with a nurse crop, usually with buckwheat.

In beginning to improve the poorer land in the coastal plain section cowpeas should be grown on the land before attempting to get a stand of crimson clover. The beneficial influence of the cowpeas does much to insure success with the crimson clover crop. The application of from 200 to 300 pounds of acid phosphate per acre is likewise of great importance in starting crimson clover on poor land. In all cases the seed should be covered lightly instead of sowing on the surface and trusting to rains to effect a covering. Artificial inoculation is also an important item which should not be omitted. (For a full discussion of the general methods of growing and utilizing crimson clover, see Farmers' Bulletins 550 and 579.)

Until the soil is built up slightly and the few special requirements just mentioned are complied with, it is more difficult to grow crimson clover than it is to grow cowpeas, but the great value of crimson clover and the place in the cropping system which it fills, as cowpeas and

some of the other legumes can not, make it highly important that crimson clover be made one of the crops grown regularly in the cropping system. Figure 3 shows how luxuriantly crimson clover grows on some of the poorer lands of this section after some of the requirements of the crop have been met.

SOY BEANS.

The soy-bean crop is not grown as extensively in the region as it should be. While similar to cowpeas in regard to growing season and the place occupied in the cropping system, soy beans as a rule are a more profitable crop than cowpeas, except on very poor land. For starting the improvement of very poor land cowpeas have given better results than any other crop yet tried. On land where soy beans have not previously been grown, artificial inoculation is usually necessary

FIG. 3.—Crimson clover is one of the most valuable crops grown in the area.

for best results. Once the land becomes thoroughly inoculated, which it usually does the second successive time they are grown on the same land, the yield of both seed and forage is usually greater than the yield from cowpeas.

Soy beans are especially valuable for feeding farm animals. The yield of seed is usually double that of cowpeas, and the hay is of equally good quality and easier to cure than cowpea hay. Soy beans are much used as a crop for hogging-down, either when sown alone or with corn. When cut and stacked this crop has given especially good results as a winter feed for hogs in connection with a light ration of corn. The value of soy beans, both as a feed crop and for the improvement of soil, warrants a much greater acreage than is at present grown in this section. (For full information on this crop, see Farmers' Bulletins 372 and 886.)

VETCH.

Hairy vetch is well adapted to the soil and climatic conditions of the region, but on account of the lack of information on the methods of growing and use of the crop it is not grown generally. The marked success by a great many farmers who grow vetch regularly warrants a more general use of this crop for soil improvement in this region. Sown with grain in the fall, it has the advantage of being more hardy than crimson clover and can therefore be sown much later in the season without danger of winter-killing. This crop, like crimson clover, occupies the land during the fall, winter, and spring, acting as a cover, and conserves soil fertility. The mixture of vetch and grain is usually cut for hay in May, depending on

FIG. 4.—An excellent growth of wheat and vetch for hay and soil improvement.

the grain with which it is sown. After the hay is cut the land can be planted to corn, cowpeas, soy beans, or tomatoes. This makes the crop a valuable addition to the ordinary cropping system of the region. As shown in figure 4, the crop produces a good growth of hay and a large amount of organic matter to be plowed under.

The methods of growing vetch are comparatively simple. The seed is usually mixed with grain and sown with a drill at the rate of about 30 pounds of vetch to one bushel of wheat or rye per acre. It has been the usual practice to sow this crop without paying much attention to inoculation. In some parts of the region it is advisable to inoculate the seed in order to insure a good growth. (Complete details of growing this crop are found in Farmers' Bulletin 515.)

RED CLOVER.

On the lighter soils of the area red clover is not commonly grown, but on the heavier types, where the cropping system usually includes small grain, red clover is of considerable importance. Red clover occupies a very different position in the cropping system from that of any of the crops referred to above. It is usually sown in the spring on small grain and comes to maturity the following year, being used either for hay or pasture. In many instances crimson clover is used in the same cropping system with ordinary red clover, but on land that produces red clover without difficulty crimson clover is not grown to any great extent. Light applications of lime have been found to be very beneficial in promoting the growth of red clover on the heavier soils of this region. The application of lime and an increase in organic matter usually makes it possible to grow red clover successfully on many of the lighter soils. (For further information regarding this crop, see Farmers' Bulletin 455.)

RYE.

This crop is used in many different ways by farmers of this region. It is especially well adapted to use as a winter cover crop for the reason that it can be sown at almost any time during the fall and early winter without danger of winter-killing. As soon as growth starts in the spring it can be pastured for 4 to 6 weeks and then allowed to grow up for turning under as a green manure. The practice of sowing a mixture of rye and crimson clover is followed in many instances and usually gives better results on thin land than either of these crops sown alone. With a crop such as rye always at hand and seed at a reasonable price, there is little excuse for any of the farm land in this region to be without a cover during the winter months.

BUCKWHEAT.

In the improvement of the soils of this area buckwheat is used to great advantage. It is a convenient crop to manage, as it can be sown at almost any time during the growing season and is ready to turn under in about eight weeks after planting. The short growing period required allows buckwheat to be grown after the removal of other crops, and also to be sown ahead of and turned under before late planted crops need be planted. Not being a legume, the main advantage of buckwheat in connection with soil improvement is the addition of organic matter. In many parts of the region the usual practice is to sow buckwheat and crimson clover in July. The buckwheat is allowed to mature and is harvested for the grain, and the crimson clover then has full possession of the land for the remainder of the year. This practice reduces the expense of sowing the crimson clover, in that the buckwheat crop usually is sufficient to pay the expense of the entire operation. The fact that the crimson clover is sown early and makes a good growth before cold weather sets in is a distinct advantage from the soil-improvement standpoint.

THE USE OF FERTILIZERS.

The farmers of the region who are getting the best results from the use of fertilizers, especially those who are growing general farm crops, are maintaining a high percentage of organic matter in the soil and fertilizing from the standpoint of the needs of the soil in general rather than the fertilizer requirements of the individual crops. Except for potatoes and truck crops, it is wiser economy to use commercial fertilizers in a definite plan of more permanent soil improvement rather than to make light applications principally for the purpose of stimulating the one crop to which it is applied. It is doubtless good business practice to apply fertilizers to a crop and thus increase the production over and above the cost of the fertilizers and the extra labor, but it is still better to accomplish this in such a manner as to effect a more permanent improvement of the soil, which will serve to benefit several crops in succeeding seasons.

The soils of the coastal plain of the Central Atlantic States need nitrogen and humus first of all. The full effect of fertilizers can not be realized on the average soil of the region until this need has been met. After this the application of phosphorus is of great importance and, on the lighter soils especially, the application of potash is distinctly beneficial. The nitrogen is most economically supplied by growing legumes and the turning under of crops. Phosphorus is usually supplied in the form of acid phosphate. For general purposes potash is best supplied through the use of muriate of potash or kainit. At present (1917) the price of potash salts is such as to render it impracticable to apply potash to general farm crops under average conditions. Under normal conditions, however, if sufficient attention is given to maintaining the nitrogen supply in the soil, most satisfactory results are obtained by the use of a fertilizer containing both phosphorus and potash. Such a fertilizer can either be purchased on the market or made on the farm by a process of home mixing.

The fertilizer practice that has given best results on the farms of this region follows the general plan of applying the fertilizer to the crop that is grown especially for soil improvement. Two or three hundred pounds of acid phosphate, for instance, applied to crimson clover that is to be turned under for corn gives much better returns under the average soil conditions of the region than the same amount applied to the corn crop directly. Many of the best farmers are now following the practice of applying the fertilizer to the legumes and grass crops that are grown to supply the nitrogen and organic matter necessary to the building up and maintenance of fertility in the soil. The same holds good in the application of manure. Manure applied on grass land one or two years in advance of the time it is plowed for corn increases the growth of grass, makes more hay and pasture, and a better sod, and hence more organic matter to be plowed under. Such a process is usually better

and the effect more lasting than to apply the manure during the preparation of the land for the corn crop.

In addition to the fertilizing elements which are used, the soils of the coastal plain region quite generally need lime. Lime is especially beneficial in growing red clover, alfalfa, and vetch. Its effect is likewise good on crimson clover, but is not an absolute necessity. Soy beans and cowpeas usually grow well on most of these soils without the application of lime. While an application of lime is generally beneficial in the growing of legumes and assists in the improvement of the soil, it is often difficult to tell whether lime or organic matter is needed most. In numerous instances the beneficial effects which are attributed to lime on especially poor soils are secured with equal effectiveness by adding large quantities of organic matter. In general farm practice in the region it is better to begin with the growing of such legumes as thrive on extremely poor soils and first build up the organic matter and nitrogen by plowing these crops under. In many instances it is found that a profitable system of farming can be established and clover and such crops as had refused to grow satisfactorily can be grown to good advantage by incorporating humus without the application of lime. If, however, after materially increasing the organic matter in the soil by the use of such crops as crimson clover, soy beans, rye, and buckwheat, the need of lime is indicated, it should be supplied by applying ground limestone or ground oyster shells. The test by which the farmer can determine whether his land needs lime is to lime a small part of a field and see if it increases the growth of his soil-improving crops, especially the clovers and grasses.

CROPPING SYSTEMS.

Comparatively few farmers of the coastal plain region in the Central Atlantic States follow a definite crop rotation. While a fixed rotation is in many respects very desirable from the standpoint of soil improvement, it is not absolutely necessary and in many cases not desirable. Most farmers prefer to follow a cropping system that is more or less flexible so that a shift can be made in the order of cropping when a change in prices or variation of seasons should make a change necessary.

In beginning the improvement of land it is preferable generally to start with a more or less definite succession of crops which may later be changed to a cropping system more suited to the type of farming which is being followed. On the poorer lands the best results are obtained by starting with a system of cropping which is extreme in the matter of growing crops for the express purpose of increasing the organic matter in the soil. The following is a good example:

First year	Cowpeas followed by rye.
Second year	Cowpeas followed by crimson clover.
Third year	Corn followed by crimson clover.

In the first year of this plan the cowpeas are plowed under and rye is sown in the fall. The rye is allowed to grow until about May 1 of the next spring when it is plowed under in preparation for the cowpea crop of the second year. The cowpeas of the second year may be either plowed under or cut for hay, the former method being preferable, as it will still further hasten the soil improvement. In the fall of the second year crimson clover is sown for the first time. Generally, by this time the soil has been sufficiently improved so that by the use of some fertilizer a reasonably good stand of crimson clover can be obtained. (See Farmers' Bulletin 550.) The crimson clover crop is permitted to grow until about May 1 of the third year when it is plowed in preparation for the corn crop. It is advisable, also, at the last cultivation of the corn crop of the third year to sow crimson clover for hay or to be plowed under the next season in preparation for other crops. The process of soil improvement by this plan of cropping may be made still more effective by applying 200 to 300 pounds of commercial fertilizer per acre on the cowpeas.

On lands which are not so extremely run down, which are still producing fair crops of corn, such radical measures will not be necessary. In many cases a legume or other humus-forming crop can be included in the cropping system without much extra expense, and at the same time greatly improve the fertility of the soil. Under some conditions—as, for instance, on the farms of the region that grow a variety of small fruit and truck crops—it is desirable to grow the same crop continuously on the same land. This is especially true of corn. There are a number of examples where this is being done successfully by the following plan of cropping:

First year	Corn with crimson clover sown at last working.
Second year	Crimson clover turned under and corn again planted. Crimson clover sown at last working.
Following years	Repetition of second year.

Under ordinary conditions the yields of corn can not be maintained continuously one year after another on the same land, but with this system, especially with the application of small amounts of fertilizers each year, the yields are being maintained and even increased. By plowing down a crop of crimson clover each year the supply of organic matter is maintained at a high point, and corn can be grown by this system continuously so long as root lice or corn diseases do not make it impracticable. If this happens, it becomes necessary to grow other crops for a few years, after which the old process can generally be repeated for a number of years on the same land. In this, as in all other cropping systems in successful operation in the region, one of the most important features is keeping up a liberal supply of organic matter.

A system of farming that has maintained crop yields on the farms of a large estate in eastern Maryland is described in Farmers' Bulletin 437. The records kept by the estate show that crop yields are about the same now as they were 30 years ago—corn, 30 bushels;

wheat, 17 bushels; and clover hay 1½ tons per acre. These yields are not large, but the fact that they have been maintained for so long a period in a section of country where yields of the same crops on adjoining farms are very much lower is of interest. The soil varies from a sandy loam to a clay loam. The crop rotation practiced is:

(1) Corn.
(2) Wheat.
(3) Clover for hay and pasture.
(4) Wheat.
(5) Clover for hay and pasture.

All of the wheat and about three-quarters of the corn grown are sold. The hay and one-quarter of the corn are fed, and the corn stover and wheat straw are utilized as feed and bedding, and the manure returned to the land. The manure is spread on the clover sod and turned under for corn. Each wheat crop is fertilized with commercial fertilizer analyzing 2 per cent nitrogen, 8 per cent phosphoric acid, and 2 per cent potash, at the rate of 300 pounds per acre.

The essential difference between the system of farming on these farms and others of the community is not so much in the fertilizer used as in the rotation and disposition of the crops—a five-field system with two of the fields in clover each year as against a five-field system with one field in clover each year. The clover provides a large amount of nitrogen and humus, so much needed in these soils. The system of renting on these farms encourages the renter to keep live stock and results in all the hay, straw, and corn stover, and part of the corn being fed on the farms and the manure returned to the land.

The production of small fruit and truck crops throughout much of the region necessarily makes the cropping system on many farms more or less irregular. But even on farms devoted largely to the growth of truck and small fruits provision must be made for supplying organic matter to the soil if yields are to be maintained. Organic matter can usually be supplied in such cases by growing winter cover-crops of crimson clover, rye, or vetch. These cover crops can be sown after such crops as potatoes, cantaloupes, tomatoes, and also in standing corn to good advantage. The following four-year rotation, which provides for growing feed for live stock and also some wheat and truck crops for sale, is well adapted to much of this region and will rapidly improve the land:

First year	Corn. Cowpeas sown at last working of the corn to be disked in for wheat.
Second year	Wheat. Red clover sown on the wheat in early spring.
Third year	Clover cut for hay.
Fourth year	One-half in tomatoes, followed by crimson clover. One-half in potatoes, followed by crimson clover.

Cowpeas are sown in the standing corn at the last working and after the corn is cut the peas are disked in for wheat. If manure is available it should be used as a top dressing on the wheat during the

winter and spring before the red clover is sown. This practice insures a good catch of clover. The following year, or the third year of the rotation, the clover is cut for hay. This leaves a good red clover sod that can be plowed in the fall for early potatoes and tomatoes the next spring, or the fourth year of the rotation. After these crops are harvested crimson clover is sown to be turned under the following spring for corn. This rotation not only provides an abundance of organic matter and nitrogen, which keeps the land in a productive condition, but also gives a fairly even distribution of both man and horse labor.

Numerous other cropping systems are in use in the region, some of which are quite effective in building up and maintaining crop production, but these examples illustrate some of the more important features to be considered in formulating cropping systems which are suited, in whole or in part, to most general farms of the area. In addition to the effectiveness of the cropping system the question of financial returns must be considered, as well as the conditions of the individual farm and the finances of the individual farmer.

PRACTICAL MEASURES.

Building up the fertility of the soil is an economic problem as well as an agricultural problem and must have the most careful consideration from this standpoint. Expenditures must be justified by the increase in crop yield either at once or at some time in the near future if the enterprise is to be successful. The kind of crop that is grown and the price received are important factors, since these affect the margin of profit and consequently the amount of money available for improvement.

The rate at which this improvement is to be made must be governed to a certain extent by the amount of capital available for the purpose. With the necessary capital available, the improvement may be carried on rapidly and the soil built up in a comparatively short time. With little or no capital available more time is necessary and the improvement must be brought about gradually. The latter course has its advantages in that there is more time to become familiar with important details, and there is also less danger from losses by putting more money into the soil than returns will warrant, which may occur when the improvement is brought about rapidly.

In this connection, also, the type of farming should be made to conform to the conditions on the individual farm. For the man with small capital, crop farming is a much more simple and more desirable type, for a few years, at least, than live-stock farming. A few cash crops well selected will generally return a reasonable income with less investment than is required for live-stock farming. There is an advantage, however, in keeping enough live stock to utilize feed that might otherwise be wasted, the manure being returned to the land.

All the real advantage, however, of keeping live stock for the manure alone can easily be gained by the use of small amounts of fertilizer and the plowing under of green crops. In starting to improve farm land in this region the tendency to rush into live-stock farming before conditions warrant the change should be studiously avoided. It is the part of wisdom to increase the live stock gradually as the soil is built up to a point where an abundance of feed can be produced easily, and as sufficient capital is accumulated to purchase fences and live-stock equipment. But in the beginning and for a considerable time thereafter crop farming and the sale of cash crops has a decided advantage in its simplicity of operation and quicker and surer returns.

The demand for farm products at the present time should greatly stimulate production. Bringing additional land into cultivation will be a factor, but on account of the scarcity of farm labor an increase in production can, in the main, be brought about more economically in this region by increasing the yield of farm crops. The difficulty of obtaining commercial fertilizers makes it necessary to rely more and more on farm sources of fertility in the production of larger yields.

The excellent results obtained by many farmers who have increased the yields of their crops by making the land more fertile through the use of a system of cropping that provides for the growing of legumes or other crops which keep the soil well supplied with nitrogen and organic matter should be of special interest at this time (1917), when the importance of better methods of farming in this region as well as others is strongly emphasized by the world shortage of foodstuffs.

An extra effort should be made to keep the soil well supplied with organic matter by arranging the cropping system so as to provide for the growing of legumes and other crops, especially winter legumes, which may serve as a cover for the land during the winter and not only prevent the loss of any fertility but actually add to the soil by the accumulation of nitrogen and organic matter which improves the physical condition of the land and lessens the need for commercial fertilizers and lime. For this purpose crimson clover is by far the most important winter legume grown in the region. Hairy vetch and rye are also good winter crops, while cowpeas, soy beans, and buckwheat are excellent summer crops for soil improvement and also for grain and forage. The ordinary red clover has long been grown in regular rotations with small grains for hay and soil improvement, but more attention should be given to securing a good stand and vigorous growth of this important crop.

EXAMPLES OF SOIL IMPROVEMENT.

In the following pages a few concrete examples will be given to illustrate more fully some of the valuable work that has been done in all parts of the north coastal plain region by enterprising

farmers. While a large number of these examples could be given, only a few which are representative of the simplest as well as the highest type of work of this kind will be cited.

A CORN FARM.

On one farm in Caroline County, Va., the regular practice had been to grow corn on the land one year in three and to allow each field to "rest" during the other two years. The "resting" process was to allow weeds and trash to grow up and thus accumulate sufficient fertility for another crop of corn. With this system of cropping the yield of corn ranged generally from 15 to 18 bushels. Figue 5 shows the crop growth on a part of the farm which was still under this system.

FIG. 5.—Yield too low to pay the labor, much less a profit.

The improvement of the soil on this farm began first by planting one of the poorest fields to cowpeas. The cowpeas were cut for hay and the stubble disked and seeded to crimson clover. The following spring the crimson clover crop was turned under and the field planted to corn. At the last working of the corn, crimson clover was again sown. The following spring the same process was repeated by turning under the crimson clover and planting corn again on the same land. This practice was continued for five years. The third year the yield of corn was about 40 bushels to the acre and the fifth year the crop made a yield of 50 bushels to the acre. Figure 6 shows the change that has taken place under this method of cropping.

Up to the time of the change in the cropping system, it had been the regular practice to apply 200 pounds of 16 per cent acid phos-

phate per acre to each crop grown. Under that system, however, crop yields could not be maintained. After the change in cropping system, the same amount of acid phosphate was applied each year to the corn crop. The only real change in method was to grow first a crop of cowpeas and after that to turn under a catch crop of crimson clover in preparation for the corn each year. The improvement in soil conditions is further evident from the fact that after the fifth consecutive corn crop, wheat was sown and a yield of 22 bushels per acre was harvested. While these yields are not extremely large, it was possible by simple methods and with comparatively small expense to increase the producing capacity of some very poor land to about three times what it had formerly been.

FIG. 6.—Crimson clover has increased the yield of corn from 12 bushels to 50 bushels per acre in five years.

A COTTON FARM.

In Southampton County, Va., on the typical sandy land soil of the Coastal Plain is located a farm which had been cropped in corn and cotton continuously until it became so unproductive that tenants refused to work it any longer. Figure 7 shows the extent to which the soil had been reduced in fertility.

It should be borne in mind that the conditions shown in figure 7 were brought about by an improper method of crop farming. Fertilizers were used liberally both on the corn and the cotton crops, but, in spite of this fact, crop yields could not be maintained by this system.

In 1902 the farm in this condition was purchased by the present owner. With a very limited amount of capital he at once set about

improving the soil. Some of the fields were planted to cowpeas in the spring of the first year with an application of 250 pounds of acid phosphate per acre. Where the growth was good the peas were cut for hay and where the growth was small the crop was allowed to remain standing. The following spring the cowpea fields were planted to cotton with an application of 200 pounds per acre of a 2–8–3 fertilizer. Crimson clover was sown in the cotton just after the first picking. The yield of cotton was one-third of a bale per acre.

During the fall of the first year some of the fields were sown to rye with a small application of acid phosphate. The rye crop was plowed under in May of the next spring and corn was planted with-

FIG. 7.—Less than 100 pounds of lint cotton per acre. This land needs organic matter.

out any fertilizer. Cowpeas were sown in the corn at the last cultivation. The yield of corn was about 20 bushels per acre.

From the operations of the first year was developed a two-year rotation as follows:

First year.....Cotton with crimson clover.
Second year.....Corn with cowpeas.

In this rotation cowpeas were sown in the corn at the last cultivation and the crimson clover was sown in the cotton either at the last cultivation or just after the first picking, depending on the moisture conditions of the soil. Enough of the cowpeas are picked by hand for seed each year and occasionally some for sale. After the first year, both the cowpeas and the crimson clover grew to better advantage. The fourth year of this rotation the yield of cotton was 570 pounds of lint, or a little over one bale per acre, and the yield of

corn was about 40 bushels per acre. Figure 8 shows the appearance of the cotton crop after the fourth year.

A CONTRAST IN WHEAT.

Under the average conditions of the Coastal Plain section, wheat growing is not a profitable enterprise; especially is this true on the lighter, sandier soils. Some wheat is grown, however, but the yields are small. Figure 9 shows a 20-acre field of wheat in shock which yields only 8½ bushels per acre.

The wheat crop shown in this picture is typical of the results obtained on farms of the region which are situated on the poorer types of land which has been exhausted from continuous and im-

FIG. 8.—More than a bale of cotton to the acre after growing cowpeas and plowing under one crop of crimson clover.

proper cropping. It is needless to say that under these conditions the organic matter of the soil has been reduced to a very low point. The wheat crop in this instance was sown after corn, which is the usual practice, and had an application of 300 pounds of acid phosphate per acre.

For the sake of contrast and to show what better methods will do an adjoining farm which has been made highly productive may be cited. These two farms are situated in Sussex County, Del. Figure 10 shows a 100-acre field of wheat on identically the same type of soil, the yield being 30 bushels per acre.

The wheat shown in figure 10 was sown in part on a red clover sod and in part after early potatoes. The potatoes of the previous year had been fertilized with 1,000 pounds per acre of 5–7–7½ fer-

FIG. 9.—Wheat yielding but 8½ bushels per acre does not pay in this section.

tilizer. The wheat itself had an application of 300 pounds of 3–7–7½ fertilizer per acre. This farm furnishes a good illustration of the efficient use of fertilizers on light sandy soils where a special effort is made to keep up the organic matter in the soil. In many instances where truck crops or potatoes are grown this same plan can be carried out profitably.

ANOTHER DELAWARE FARM.

A farm in Kent County, Del., furnishes another excellent example of the possibility of building up run-down sandy land in the Coastal

FIG. 10.—Same type of land as shown in figure 9. Thirty bushels of wheat per acre after growing legumes and using a little fertilizer.

Plain region. When the present owner came into possession of this farm the yields of corn ranged from 12 to 15 bushels. It is of more than passing interest to know that on certain fields of this farm for the past 25 years the yields have been about 50 bushels of corn per acre. These results have been obtained on a soil made up of coarse sand with a subsoil of the same character.

The methods by which these results have been obtained are simple in the extreme and are likewise inexpensive. Corn has been grown continuously year after year. Each year crimson clover is sown in the corn at the last working. The following spring the crimson clover is cut for hay and the stubble plowed under in preparation for the next corn crop. Each corn crop receives an application of 250 pounds per acre of a fertilizer made up of equal parts of 14 per cent acid phosphate and kainit. The land is plowed about 6 or 7 inches deep, the corn is well tended, and no weeds are allowed to grow. As previously stated, the average yield of corn for the past 25 years has been about 50 bushels per acre. In addition to this an average of at least a ton of crimson clover per acre has been cut annually. While these yields are not extremely large, the fact that this sandy land has been built up by simple and practical methods and that the yields have been maintained for so long a period is a matter of great interest. Up to the present time there is no indication of these yields declining. This plan of cropping is being adopted quite generally in the community, but as yet the results do not extend over a sufficient number of years to tell what the final outcome will be.

The example of this farm furnishes a striking illustration of the building up of a poor sandy soil by the addition of organic matter and the judicious use of fertilizers while the soil was yielding a fair financial return each year by a continuous growing of crops. The fact that this soil has been built up by such simple methods and the yields maintained for so long a period teaches some valuable lessons for the region concerning fertility problems in general, and furnishes an example of the effectiveness of fertilizers in the presence of sufficient organic matter. The example is all the more remarkable because on this farm no lime and no manure has been applied and only comparatively small amounts of commercial fertilizer have been used. The main secret of this striking success in building up sandy soil and maintaining good yields is the fact that the cropping system is so arranged as to keep up the supply of nitrogen and organic matter to a point of fairly high efficiency. By such a system it is possible to build up some of the nearly depleted soils of the region and at the same time make them pay an income. These methods go a long way in meeting the problem presented by the combination of poor soil and low finances.

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CABBAGE DISEASES

L. L. HARTER

Pathologist, Office of Cotton, Truck, and Forage Crop Disease Investigations, and

L. R. JONES

Collaborator of the Bureau of Plant Industry and Plant Pathologist of the Wisconsin Agricultural Experiment Station

FARMERS' BULLETIN 925

UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Plant Industry

WM. A. TAYLOR, Chief

Washington, D. C. January, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

CABBAGE DISEASES are preventable in the main by simple means of plant sanitation.

Rotation of crops should be practiced, avoiding crops which belong to the cabbage family, such as cauliflower, turnips, Brussels sprouts, and kale. Keep down mustard and related weeds which harbor cabbage pests.

Drainage water and refuse from diseased cabbage fields will carry infection. So will stable manure with which diseased material has been mingled.

The seed bed is often the source of infection. The greatest pains should be taken to insure healthy plants. Locate the seed bed on new ground, if possible, or sterilize by steam the soil used.

Clubroot is avoided by the free use of lime and by setting healthy plants. Disinfect all cabbage seed before planting, to prevent black-rot and black-leg. Yellows is due to a fungus which persists in the soil for many years. Varieties of cabbage resistant to disease are being developed.

This bulletin is a revision and extension of Farmers' Bulletin No. 488, entitled "Diseases of Cabbage and Related Crops and Their Control."

CABBAGE DISEASES.

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CABBAGE AND OTHER CRUCIFERS.

FROM THE ORIGINAL WILD STOCK of cabbage have come cauliflower, Brussels sprouts, kohl-rabi, collards, and kale. Other cultivated plants closely related to those already mentioned are turnips, radishes, rape, broccoli, rutabaga, and charlock. Among the related wild plants shepherd's-purse, peppergrass, and mustard are of most frequent occurrence. Mustard is sometimes cultivated, but it grows so profusely under all conditions that it is perhaps better classed as an obnoxious weed. The term "crucifers" used in this bulletin refers collectively to all the vegetables and weeds mentioned in this paragraph, which belong to the botanical family Cruciferæ, so called from the form of the four-petaled flower. Practically all of them are subject to the same diseases, so that any method for the control of the diseases of cabbage or cauliflower, for example, can be applied to other crucifers as well.

HOW THE VARIOUS DISEASES ARE DISSEMINATED.

Fungous and bacterial diseases are carried from one place to another by various means, such as (1) insects, (2) infected seed, (3) transplanting from an infected seed bed to the field, (4) drainage water, (5) cabbage refuse and stable manure, (6) farm animals and tools, and (7) wind.

INSECTS AS DISEASE CARRIERS.

Insects frequently are distributors of diseases. For instance, th bacteria causing the black-rot of cabbage is carried from one plan to another and from one leaf to another by slugs, snails, etc. Insec wounds offer favorable places for infection with certain diseases. In sects which visit cabbage and other crucifers are likely to carry th germs on their bodies and deposit them on the parts of noninfecte plants. If the conditions are favorable, infection then takes place.

Certain insects are attracted to diseased areas of plants by the odor emitted therefrom. Cabbage affected with clubroot has a very offen sive odor at some stages in the development of the disease, and thi odor has been known to attract insects. New infections may b brought about by these insects visiting other plants.

INFECTED SEED.

Growers of cabbage for the market seldom raise their own seed but purchase it from seed growers. The same can be said of cauli flower and other related plants. If the seed is grown where disease are prevalent it is possible that some disease may be introduced wit the seed. The germs of some of our worst plant diseases, includin the black-rot and black-leg of cabbage, have been found to overwin ter on the seed. For this reason it is always advisable, as a precau tionary measure, to treat the seed with some disinfectant before sow ing. (See pp. 6 and 7.)

TRANSPLANTING.

Plants that are started in a crowded seed bed, which is often lo cated on old ground near the house or in the garden, are frequen carriers of diseases to a noninfected field. In such crowded condi tions diseases are readily communicated from one plant to another Some of the diseases of cabbage and cauliflower, such as clubroot are known to be distributed to some extent by insects. The insects burrowing through the ground or feeding upon the roots, carry th disease from the roots of one plant to those of another. The loss i the field can be greatly reduced if care is exercised to prevent the in troduction of the disease into the seed bed by proper disinfection o the seed and selection of clean soil or by soil disinfection where rota tion is impracticable.

DRAINAGE WATER.

Drainage water or the run-off during heavy rains probably fur nishes one of the most important means for the dissemination o plant diseases and has been found in many places to explain the presence of a disease in fields where cabbage or other crucifers have never before been grown. If the crop is planted on high ground the

germs from the refuse of diseased plants may be washed to the low-lying fields during heavy rains. In the hope of avoiding the disease by crop rotation, a new field on this low ground may be selected, where the disease will prove as severe as on the abandoned field.

In some sections where cabbage is grown on a commercial scale it is customary to set the plants with a machine which drops about a half pint of water for each plant. For this purpose the water from drainage ditches, which is often the run-off from a field where some bad disease has been present, being the most available, is frequently used. This use furnishes another method of spreading disease, as was illustrated in a field set to cabbage for the first time, where the water used in setting a part of the field was obtained from a well; for the remainder, water from a drainage ditch adjacent to a field planted to cabbage the previous year was used. The plants set in both portions of the field were secured from the same seed bed. The yellows was very severe where the plants were set with water from the drainage ditch; the other part of the field was free from it.

CABBAGE REFUSE AND STABLE MANURE.

A not uncommon practice is for farmers to throw the refuse of cabbage or other crops on the manure heap, the compost thus formed being hauled out and distributed on the fields the following spring. Near sauerkraut factories the refuse is often spread directly on the cabbage land and plowed under. These are bad practices if the crop is diseased, as the causal organisms may thereby be readily disseminated.

The value of cabbage leaves as fertilizer is doubtful. They contain nearly 90 per cent of water, so that even if all the dry matter had fertilizing value, the quantity is ordinarily so small as to be of minor importance. In any case, the refuse should be plowed under on fields designed for the culture of crops other than cabbage or its relatives.

DISTRIBUTION BY FARM ANIMALS AND TOOLS.

While the use of sheep or other animals in cabbage fields is recommended for saving the waste, it should be remembered that the worst diseases are perpetuated in the stem and root tissues, which are not eaten. On the other hand, grazing animals passing from the cabbage lands to other fields may scatter the germs of cabbage diseases. Many of these germs pass through the digestive tract unharmed, and in any case they are easily carried with the soil on the feet of animals. A reasonable amount of care, therefore, should be exercised so that infected soil will not be transported to new cabbage fields by cultivators and similar tools and by draft horses. While such matters are in some degree unavoidable in farm opera-

tions, these facts should always be understood and all reasonable precautions taken to avoid them, especially with such serious soil-borne diseases as clubroot and yellows.

DISSEMINATION BY WIND.

Dissemination by wind is perhaps not so important a factor in the distribution of diseases of cruciferous plants as some already mentioned. Nevertheless, in certain districts where the soil is light, where dry weather prevails a part of the year, and high winds are common, spores may be carried long distances. The diseases that are external to the leaves are more likely to be distributed in this way than parasites which are situated in the soil or in the internal portion of the plant.

FARM PRACTICE AND ITS RELATION TO THE CONTROL OF DISEASES.

Several methods by which diseases may be carried from one plant to another, from one field to another, or, indeed, from one part of the country to another have already been pointed out. In view of these facts the first aim of the farmer should be to prevent, if possible, the introduction and distribution of destructive diseases on his farm. In order to accomplish this, several precautions should be observed, of which the more important are (1) the disinfection of seed, (2) the location and care of the seed bed, and (3) crop rotation.

DISINFECTION OF SEED.

American cabbage growers, as a rule, prefer to buy seed rather than grow their own, and, in general, this custom is based on sound economic principles and will continue. Seed growing is an industry in itself, requiring specialized cultural methods and certain favorable climatic conditions. Because of these facts most of the American supply of cabbage seed is grown on Long Island or near Puget Sound, or is imported. Those engaged in this seed-growing industry are, as a rule, not well informed about most cabbage diseases and use no special precautions to insure the production of seed free from the germs of disease. Certain diseases, including black-rot and black-leg, develop on seed plants and are disseminated with the seed, and probably nearly all the other disease parasites discussed in this bulletin may do so under some conditions. It is therefore probable that disease germs are being distributed with the seed very commonly. Fortunately, the cabbage grower may easily guard against this danger by the disinfection of his seed before sowing. The process is simple and safe and is applicable to cauliflower, turnip, and other crucifers, as well as to cabbage.

Use 1 ounce of formaldehyde (40 per cent) to 2 gallons of water, or 1 teaspoonful of formaldehyde to a teacupful of water. Soak the seed 15 to 20 minutes in this solution, dip in clear water to wash off the formaldehyde, and then spread out in a thin layer to dry, stirring if needed. There is no danger of injury from slight modifications in either the strength of the solution or the length of immersion provided the seed is well washed and quickly dried after treatment.

LOCATION AND CARE OF THE SEED BED.

Cabbage, cauliflower, and some other plants of the same family are generally started in a seed bed before being set in the field. As previously pointed out, some of the worst diseases of these crops may be transferred to noninfected fields by means of the plants from the seed bed. In order to grow strong, vigorous plants as quickly as possible, compost or stable manure is applied liberally to the seed bed. The mistake is often made of placing the bed on an old cabbage field where diseases may have been present, because the soil happens to be fertile or for other reasons. Furthermore, the manure might be, and often is, taken from the heap where diseased plants have been thrown to compost, or it may be from animals that have fed on diseased cabbage. In either case there would be great danger of introducing the diseases into the seed bed. The transfer of such plants to the field would naturally mean the transfer of the diseases affecting them. To avoid this danger, always make the seed bed on new soil, if possible. Where it is necessary to use old soil which may contain germs, it should be disinfected.

Mr. W. W. Gilbert, of the Bureau of Plant Industry, recommends the following methods for disinfecting the seed beds: Sterilization (1) by means of draintile laid in the bottom of the beds, through which steam is passed; (2) by means of an inverted pan under which steam is admitted, or (3) by drenching the soil with a formalin solution.

In the tile method of steaming, lines of 2-inch to 3-inch glazed tile are placed lengthwise in the beds to be sterilized, 2 to 2½ feet apart and 15 inches below the surface, and are left there permanently. They provide drainage for the beds, may be used for subirrigation, and are available at any time for sterilizing the soil, the only outlay for labor being the covering of the beds with boards or a tarpaulin and the connecting of the tile with a boiler by means of a piece of steam hose. The soil need not be moved, and thus a large part of the labor involved in sterilization is obviated. It is advisable, however, to spade up the soil, so that the steam may more readily penetrate it.

Another method of steaming, by means of an inverted galvanized-iron pan, 6 by 10 feet and 6 inches deep, under which steam is ad-

mitted, has been used in the sterilization of tobacco seed beds and in greenhouse beds and has given very satisfactory results. The use of steam at a pressure of 80 to 100 pounds and treatment for half an hour to an hour after the soil has reached a temperature of 212° F., as indicated by soil thermometers, has given the best results.

Formaldehyde sterilization is accomplished by drenching the soil with a 1 to 100 or 1 to 200 solution of standard formaldehyde (40 per cent), at the rate of three-fourths of a gallon per square foot of area, several days before the soil is to be used. Formaldehyde, however, does not rid the soil of nematodes, as steaming does. This method has been used to good advantage in the sterilization of lettuce beds for the prevention of fungous diseases. Detailed directions for soil sterilization by the methods here outlined will be found in Farmers' Bulletin No. 736, entitled "Ginseng Diseases and Their Control."

CROP ROTATION.

Crop rotation is an essential practice, whether or not it is necessary in the control of any plant maladies. There are numerous fungous diseases which reappear year after year on the same field if a suitable host is present. Some of them, such as the clubroot of cabbage, are strictly soil parasites and can not be controlled by any fungicide. About the only method left to get rid of the organism is to starve it out, and this can be done only by a well-planned system of crop rotation. Most of the organisms like the clubroot of cabbage have a number of hosts on which they live, any one of which will serve to perpetuate the disease. It is therefore necessary to avoid planting in close succession crops that are affected with the same parasites. The length of the rotation depends largely upon the disease and the thoroughness with which the system is carried out. There are only a few diseases that will be killed out by a three or four year rotation, and instances are known where one of six or more years has failed to eradicate the malady, though its severity was greatly reduced. There are several reasons why long rotations are frequently necessary. (1) Many weeds which are overlooked by the farmer during cultivation perpetuate the diseases. (2) Certain parasites are able to live for a time on decayed vegetable matter when a suitable host is not available. Just to what extent this is the case is not always known. (3) Some fungi have the ability to remain dormant for a considerable length of time in the absence of a suitable host. The organism causing cabbage yellows, for example, has been known to be dormant in dry soil for three and one-half years and then to produce the disease. For ordinary practice, however, a rotation of four or five years is sufficient to reduce greatly the loss from most parasites. Deep and frequent cultivation, by means of which the organisms are exposed to the air and sunshine, assists in exterminating them.

FUNGICIDES.

The leaf diseases of cabbage, cauliflower, and related crops are relatively so unimportant that spraying is seldom required. The most important diseases are internal or soil parasites, which are out of the reach of fungicides.

IMPORTANT CABBAGE AND CRUCIFEROUS DISEASES.[1]

The following is a classification of the most important diseases of cabbage and cruciferous plants, with the pages of this bulletin on which they are discussed:

	Page.
DISEASES OF THE ROOT:	
Clubroot (clubfoot, finger and toe)	9
Root-knot (nematodes)	11
DISEASES AFFECTING ROOT, STEM, AND LEAVES:	
Black-rot (brown-rot, stem-rot, dry-rot)	13
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Black-leg (foot-rot, wilt)	19
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DISEASES OF THE LEAF ONLY:	
Downy mildew	25
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CLUBROOT (CLUBFOOT, FINGER AND TOE).

Description.—Plants affected with clubroot, even in the presence of abundant moisture, show in the earlier stages a wilting of the foliage in the sunshine, with recovery toward evening or when cloudy weather comes on. They are characterized by malformations of the roots in the form of swellings (fig. 1), sometimes as large as two fists. Few or no lateral feeding roots are formed. The disease generally attacks the plants when young, often in the seed bed, and plants so affected have a stunted, sickly appearance. Diseased plants seldom grow to maturity. The clubroot of crucifers might be confused with root-knot, which is characterized by similar enlargements of the roots caused by a minute eelworm, or nematode. The malformations caused by nematodes, however, are usually not so large. While present to some extent in the North, especially in greenhouses, root-knot is more commonly met with in the South.

[1] Various names are often applied to the same disease, as shown in this classification.

FIG. 1.—Enlarged roots of cabbage caused by the clubroot organism.

Control.—The clubroot organism is a soil parasite, and for that reason recourse must be made to some form of soil treatment. The organism thrives best in an "acid" soil, and in view of this fact slaked lime at the rate of about 75 bushels per acre added every few years will keep the disease in check. The lime should be added some months before planting. If the crop is to be planted early in the spring the lime should be applied the previous fall, but if a late planting is desired it can be put on in the spring.

Seedlings are very susceptible to the disease, and the utmost precaution must be taken to grow the plants on uninfected soil, or disinfection of the seed bed should be practiced. Furthermore, diseased plants should be destroyed by burning and should not be thrown on the manure pile or left in the field. Crop rotation should be practiced; and, as it has been found that the disease will live in the soil for several years, the rotation should be a long one. All cruciferous weeds should be destroyed, and no cultivated crucifers should be used in the rotation. The disease has been found in this country on cabbage, cauliflower, rutabaga, turnips, radishes, Brussels sprouts, and mustard among the cultivated plants and on some of the weeds of the same family. It probably occurs on many others.

No variety of these crops is known to be positively resistant to clubroot, though the Hollander variety of cabbage is claimed by some growers to be partially resistant. It has also been observed that the varieties of blue or red cabbage are less susceptible to clubroot than the Succession variety. Unfortunately, however, though apparently more resistant, these colored types are not good for all commercial purposes as, for example, the manufacture of sauerkraut.

Distribution and loss.—Clubroot has been known in Europe for more than a century. It occurs in England, Holland, Russia, and other European countries. Its presence in Australia has been known for a number of years. It has also been reported from New Zealand

and from 20 States in this country and probably occurs in many more. It is present over most of the country east of the Mississippi River. In some seasons, from 40 to 50 per cent of the crop in the affected fields is lost by this disease.

Cause.—Clubroot is produced by the invasion of the roots by a slime mold,[1] one of the lowest forms of life. At one time insects were suspected to occasion this disease, largely because they were frequently present in the swellings of the roots. It is now known that they are attracted by the odor of the decaying roots. The slime mold causing clubroot is composed of a mass of motile protoplasm within the roots of the plants. Later it breaks up into numerous fruiting bodies, or spores. The spores then germinate and the content escapes as several irregular masses of protoplasm, each provided with a whiplike appendage. When they come in contact with the proper host they enter the tender roots and form the disease anew.

ROOT-KNOT (NEMATODES).

Description.—Some confusion is likely to result in trying to distinguish between root-knot and clubroot. While the organisms causing the two diseases are quite different, the effects produced on the roots bear some points of resemblance. (Compare figs. 1 and 2.) Root-knot, as a rule, is characterized by smaller swellings than clubroot, more of the lateral feeding roots are affected, and the nodules are located nearer the tips of the roots. If upon breaking open the swellings on the roots pearly white bodies about the size of a pinhead are found, root-knot is to be suspected. These white specks within the swellings are the enlarged egg-bearing female eelworms, which cause the disease. The interior mass of clubroot is slightly pinkish or

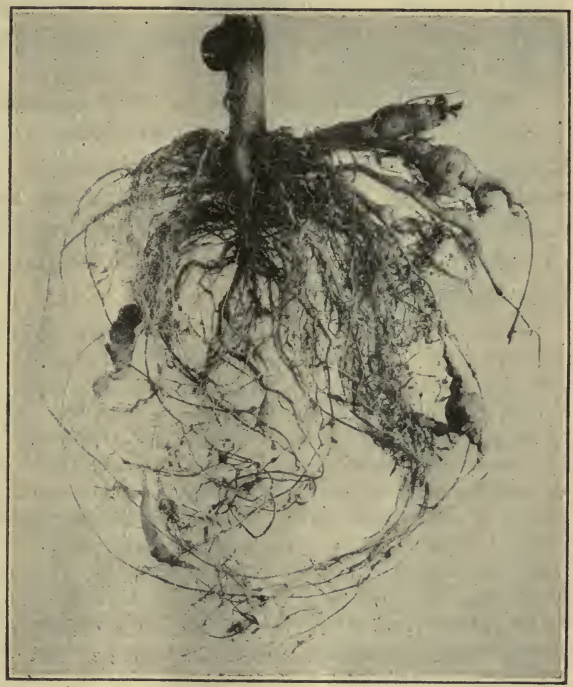

FIG. 2.—Enlarged roots of cabbage caused by nematodes.

[1] *Plasmodiophora brassicae* Wor.

brick colored. Root-knot affects a great variety of unrelated plants, while clubroot, so far as known, occurs only on crucifers.

Furthermore, root-knot is confined largely to the light, sandy soils in the South, although it may occur in the Northern States.

Control.—Crop rotation has been found to be a most effective means of controlling this disease, the object being to use crops immune to root-knot for the purpose of starving out the worms. When this method of eradicating the disease is employed, a rotation of at least three years, accompanied by clean cultivation, should be practiced. There are some 480 different species of plants already known to be susceptible to root-knot, among which are many cultivated plants and numerous weeds. Crops known to be immune or highly resistant to the disease that can be used in the rotation are corn, winter oats, rye, timothy, pearl millet, sorghum, wheat, crab-grass, the Iron and Brabham cowpeas, velvet beans, peanuts, and beggarweed. Some of the cultivated crops susceptible to the disease and, therefore, to be avoided in the rotation are alfalfa, vetch, soy beans, cowpeas (except the Iron and Brabham), clover, tomatoes, cotton, okra, cucumbers, cantaloupes, watermelons, celery, beans, sweet potatoes, tobacco, potatoes, peaches, figs, mulberries, and all crucifers.

If the disease occurs in the seed bed or greenhouse, the soil should be sterilized by live steam in accordance with one of the methods referred to on pages 7 and 8.

Distribution and loss.—Nematodes on different crops have been found widely distributed, but more especially in tropical and subtropical climates. Their greater abundance in warm climates indicates that they are natives of the Tropics, and when found in the colder climates they have probably been introduced. The total loss caused by nematodes is very great, much more than is generally appreciated.

Cause.—Root-knot is caused by a parasitic eelworm (*Heterodera radicicola* (Greef) Müll.) one-twentieth to one-sixtieth of an inch in length. It penetrates the small roots and causes irregular swellings of various sizes. The nematode enters the roots in the larval stage. It then becomes motionless and gradually enlarges. After its entrance into the host, changes take place, the male retaining the worm shape and the female becoming pear shaped. Each female lays several hundred eggs. Under favorable conditions a full life cycle can be completed in about four weeks. Nematodes migrate slowly in the soil, the distance covered in a single year probably not amounting to more than 1 or 2 yards. They are dependent upon foreign agencies for means of wide distribution. Nematodes probably pass the winter in the soil in the larval stage, though it is claimed that they winter in the roots of perennial plants in the mature stage. For a fuller discussion of this subject see Farmers' Bulletin 648, entitled "The Control of Root-knot."

BLACK-ROT (BROWN-ROT, STEM-ROT, DRY-ROT).

Description.—Of the symptoms of the black-rot, Dr. Erwin F. Smith says:[1]

The disease may appear in the plant at any stage of growth and is characterized by the following symptoms: Dwarfing, or one-sided growth of the heads, or, if the disease is very severe and has begun early in the season, by the entire absence of any heads, and in extreme cases by the death of the plant. Occasionally the heads rot and fall off, but this is not a necessary consequence, the soft, bad-smelling rot being due to the entrance of other organisms. If the stumps of affected plants are broken or cut across, a brown or black ring (fig. 3, *a*) will be observed, corresponding to the woody part of the stem, this part of the stem being especially subject to the disease. In bad cases this blackening may be easily traced upward into the center of the head and is generally worse on one side.

FIG. 3.—Black-rot: *a*, Section through a cabbage stem, showing the conspicuous ring of black bundles caused by the black-rot organism; *b*, infection through the veins at the margin of a leaf; *c*, a cabbage leaf, showing the blackening of the veins as a result of the invasion of the black-rot organism.

Infection usually takes place at the margin of the leaf (fig. 3, *b*). The progress of the disease from the point of infection can frequently be traced through the veins of the leaf (fig. 3, *c*) by the blackening of the bundles. The marginal infection is later followed by a browning and drying up of the infected areas of the leaf.

Control.—It is to be regretted that no sure methods for controlling black-rot are known, but the observance of certain precautions will prevent serious loss from this very destructive disease. (1) The germs are known to be carried on the seed; therefore, all seed should be disinfected before sowing, in accordance with the method described on page 7. (2) Care should be exercised in the preparation of the seed bed, and only manure and soil should be used that are known to be free from the disease. (3) Crop rotation, whether for the prevention of disease or not, is always a good practice. In

[1] Smith, Erwin F. The black-rot of the cabbage. Farmers' Bull. 68, pp. 5–6. 1898.

connection with black-rot it is very important. To control the disease by this method the rotation should be one in which no cultivated crucifers or cruciferous weeds are allowed to grow in the ground for four or five years. (4) Insects, slugs, snails, etc., by crawling from infected to noninfected plants carry black-rot organisms; when possible, they should be kept in subjection. (5) Live stock should not be allowed to roam at will over diseased cabbage patches, as they may carry the organisms to noninfected fields. (6) Diseased plants as soon as detected should be pulled up and destroyed and not thrown on the manure heap to compost.

Distribution and loss.—Black-rot has been reported from many States east of the Mississippi River and from a few west of it. For 20 years or more it has been destructive in the States of Ohio, Wisconsin, Michigan, and New York. In recent years several other States, particularly Virginia, Iowa, New Jersey, and Texas, have reported outbreaks. The disease has been injurious to cabbage as far south as Florida, and extends through all the States north into Canada. In 1908 it was reported from the State of Washington, but it has not occurred to our knowledge in any of the Rocky Mountain States with the exception of Colorado and Arizona. It is also well known in almost all parts of Europe and has been reported from the islands of Cuba, Porto Rico, and New Zealand.

The loss to cabbage and related plants from black-rot probably exceeds that of any one of the other diseases. It does not end in the field. It often happens that an apparently sound head is found to be rotten inside. The difficulty of detecting such heads and the fact that some are overlooked in handling result in placing many in storage, where they further decay.

Cause.—Black-rot is caused by a yellow bacterium.[1] Infection takes place through the leaves and occasionally through the roots. When infection takes place through the roots the organism spreads throughout the plant by following up the woody portion inside the stem (fig. 3, *a*). Probably most of the infections, however, take place at the margins of the leaves, either through punctures made by leaf-sucking insects or in the small droplets of water which collect at the margins of the leaves during cool nights and in damp, rainy weather. The organisms then find their way into the interior of the plant.

It is not positively known how the organisms get to the points of infection on the leaf, but presumably they are carried there on the bodies of insects or lodged on the leaf from the dust in the air. The progress of the disease from the point of infection is inward and downward. It follows the bundles of the leaf. The portion of the leaf around the point of infection, except the fibrovascular bundles, first turns yellow, then brown, and finally dries up. The veins of an infected leaf are black. Infection may take place at several points on the same leaf and on several leaves of the same plant. In the course of time the disease advances to the base of the leaf and enters the stem, from which point it may infect many other leaves and work up through the center of the head.

[1] *Bacterium campestre* (Pammel) Erw. Sm.

YELLOWS (YELLOW-SIDES, WILT, DRY-ROT).

Description.—Infected plants usually show the characteristic symptoms of the yellows in two to four weeks after transplanting, but the disease may appear earlier in the seed bed. The parasite first injures the fibrous root system and thus stunts the plants and gives them a lifeless, yellowish green color. Sometimes the yellowing is uniform; more often it is worse on one side, causing a lateral warping or curling of stem and leaves (fig. 4). Early symptoms of the disease can be seen by cutting across the base of the stem, where the invaded vessels of the woody ring show a darker water-soaked color. This color deepens with the progress of the disease and the overlying tissues gradually die and collapse, resulting in a discolored sunken surface and the curving or warping of the stem already mentioned. The yellowed plants early shed their lower leaves while making a weak attempt to continue growth above. In the worst cases, death may result within two weeks or so after transplanting, but most of the plants continue a sickly existence for a month or more, and a few live through the summer, heading imperfectly (fig. 5). In these later stages when the interior blackening is most pronounced it may be difficult to distinguish yellows from black-rot; therefore the two diseases are often confused.

FIG. 4.—Cabbage yellows: A seedling plant dwarfed and leaves curled by one-sided infection. A normal plant of this age should be twice as large.

Control.—Disinfection of the seed (p. 7) reduces the danger of bringing the disease to new districts. The germs persist indefinitely in the soil, however, if once introduced. Sanitary measures and crop rotation are recommended, but these alone do not suffice to control yellows. Seed-bed infection is one of the worst dangers; hence, great care should be taken to plant the seed in clean soil. Steam

sterilization may be practiced to advantage by truckers, but, of course, for extensive field operations this can not be done. Even if perfectly healthy plants are transplanted into an infected field they may be attacked badly. The only safety, therefore, lies in either planting the crop on disease-free land or else in using only yellows-resistant varieties (fig. 6) as listed below.

FIG. 5.—Cabbage yellows, later stages: Where the plants are not attacked too severely or are somewhat resistant they may continue a sickly existence through the season. Such plants are yellowish and the lower leaves keep dying and falling. The attack is often worse on one side, warping or curling the stems.

In infected districts especial precautions are necessary to check the spread of yellows to new soil. Farm tools, animals, and surface water are common carriers, and a case is recorded where the disease was introduced by using infected drainage water when setting the plants.

Resistant varieties.—There is a marked difference in varietal susceptibility to yellows, and by selection highly resistant strains have been secured. The Volga and Houser are the hardiest of the older domestic varieties. The Wisconsin Hollander is a disease-resistant

selection from the standard winter variety Hollander and should be used wherever the winter crop is grown on "yellows-sick" soil. Commercial cabbage growers are urged to give attention not only to securing resistant strains but to improving them. Certain cabbage growers where "yellows-sick" soil occurs should make a practice of selecting the best types of healthy heads (fig. 7) from infected fields and from these grow seed for local use.

Only a limited supply of the yellows-resistant cabbage seed is as yet produced, and this is largely of the Hollander variety, adapted to Wisconsin conditions. Other varieties resistant to the disease must yet be developed in the various localities in which they are grown, and cabbage breeding for this purpose is now under way

FIG. 6.—Cabbage yellows: Commercial Hollander, a nonresistant variety (on the left), showing only a few sickly plants still alive among the weeds. Wisconsin Hollander, a resistant variety (in the rest of the field), giving practically a full stand.

in several States. The growers wishing seed of resistant strains should write directly to the director of the experiment station in the State in which they reside.

Distribution and loss.—Cabbage yellows occurs seriously from Long Island to Iowa, including the southern parts of New York, Michigan, Wisconsin, and Minnesota, and southward as far as cabbages are grown as a summer crop. It is worse in warm, dry summers, and does little or no damage in the cooler extreme northern sections or along the northern Pacific coast, while the winter-grown cabbage of the Southern States also escapes the disease. In certain intensive cabbage-growing sections in the region indicated, especially in the latitude of New Jersey and Maryland westward to southern Wisconsin and Iowa, this disease has been rapidly increasing in

extent and seriousness. In bad seasons it may destroy 90 per cent of the crop and, indeed, is the limiting factor in success with cabbage as a field crop.

Cause.—Cabbage yellows is caused by a soil fungus.[1] This organism when once introduced seems capable of persisting indefinitely in favorable soils, although cabbage is not grown. The parasite requires high temperatures and even on the "sickest" soils it does not attack the cabbage until the soil warms up to about 60° F. or above, which in the Northern States means midsummer. This explains the variations in the seasonal and geographical distribution of the disease, cool, moist summers tending to lessen the loss and hot, dry seasons to aggravate it.

Infection takes place through the young roots, and it is especially injurious, therefore, immediately following transplanting, when the new root system must be developed.

FIG. 7.—A field with "cabbage-sick" soil, most of the plants having been killed by the yellows. A few plants have withstood the disease and if such are selected for seed and the process repeated for several years a resistant strain may be secured.

The vegetative part of the fungus consists of minute, colorless threads called the mycelium. This develops rapidly within the stem and leaves, which are killed and discolored as it progresses from the young roots upward through the stem and leaves. By thus crippling or destroying the absorbing and conducting systems of the plant, gradual starvation results.

Three forms of reproductive bodies (spores) are known. One type is composed of colorless sickle-shaped bodies divided into two or more parts. These are formed on the surface of the dead cabbage plant. Another form is colorless, oval in shape, and often formed within the vessels of the host. A third type is roundish, thick-walled, and able to withstand severer weather conditions; hence, it is especially adapted for overwintering or wide dissemination of the fungus. It is probable that the fungus not only lives over on old

[1] *Fusarium conglutinans* Wollenw.

cabbage stumps but persists indefinitely on decaying vegetable matter in the soil, even producing its spores and disseminating itself in this way.

Closely related species of Fusarium cause numerous diseases of other crops. Among those well known and commonly met with are the dry-rot of potatoes, the scab of wheat, and the wilt diseases of sweet potato, flax, tomato, cotton, and cowpea. These diseases are, however, all distinct from that of the cabbage; hence, any of these crops may safely be rotated with cabbage.

BLACK-LEG (FOOT-ROT, WILT).

Description.—Black-leg is known as a destructive disease on only cabbage and cauliflower, although it may attack Brussels sprouts, kohl-rabi, collards, rape, kale, rutabaga, turnip, radish, sweet alyssum, and various related cultivated and weed plants of the mustard family. It may invade almost any part of the plant, but the worst damage occurs when it blackens and kills the stems of young plants in the seed bed or field; whence its common names.

FIG. 8.—Black-leg of cabbage, showing the death and blackening of the main root, with feeble development of the new side roots above.

The earliest symptoms may appear in the seed bed two or three weeks before transplanting time. Infection frequently occurs on the stem near the surface of the ground, causing dark sunken or irregular areas. From these spots the disease spreads, gradually killing the base of the stem and root (fig. 8), so that the plant wilts and perishes. Such wilting of the entire plant is characteristic of the advanced stages of black-leg, and the leaves adhere to the stem (see fig. 10), instead of falling off as in yellows. Frequently plants attacked by black-leg show a purpling of the leaves as the first conspicuous symptom, even before any wilting occurs. Often the disease may appear as dead spots on the older leaves or leafstalks, and with seed plants the spotting of the flowering branches and seed pods

is common. It is often difficult to distinguish the stem-rot caused by black-leg from maggot injury, the more so as the two often occur together. Certain other fungi also cause leaf spots resembling those of black-leg. (See pp. 28 and 29.) It is, therefore, important to note that the peculiar character of black-leg which serves to distinguish it is that in its advanced stage the dead areas are covered with minute black specks, like pin points (fig. 9). These are the fruiting bodies of the parasite (pycnidia) filled with the spores by which the disease is disseminated and overwinters.

Control.—The black-leg parasite is harbored in the soil by these fruiting bodies on fragments of the diseased stems and leaves, which may persist two or more years until the old stumps are fully decayed. It is common in seed fields, especially in the Eastern States and in Europe, and where it so occurs the seed may carry the infection. The most serious trouble arises from seed-bed infection, either from the use of infected seed or making the bed on infected soil. The first precaution, therefore, lies in seed disinfection (p. 7); the second, in the selection of clean soil for the seed bed. If old soil must be used, it should be steam sterilized where practicable (p. 7).

FIG. 9.—Black-leg of cabbage: A portion of a leaf showing injury at two separate places, in which numerous small black fruiting bodies of the organism are produced.

In case of bad developments crop rotation should be practiced, and in general sanitary measures are to be recommended. These involve such precautions as can reasonably be taken to destroy or keep from scattering diseased materials. It is a good practice to remove promptly and bury deeply or burn diseased plants, to be careful about scattering diseased plant leaves on noninfected land, and to restrain stock from roaming from infected to noninfected fields.

Distribution and loss.—Black-leg occurs very generally in the regions where cabbage has been grown for long periods. In the United States it is more common in the East and North than westward and southward, although it is reported from Alabama on cabbage, and from the Pacific coast regions (Oregon) on rape as well

as cabbage. It is to be expected sooner or later wherever intensive cabbage culture is established.

The loss is ordinarily small if proper precautions are taken as to sanitation, seed bed, and rotation. Where these are disregarded the loss may range from 5 to 10 per cent up to 50 to 100 per cent of the crop (fig. 10).

Cause.—Black-leg is caused by a parasitic fungus.[1] This may be carried with the seed and persists in the soil. The first infections commonly take place in the seed bed, more often in the stems than on the leaves. Maggot or other insect injuries favor these, although infection occurs readily in the absence of wounds. The rate of development varies widely with temperature and moisture, but as a rule the parasite kills and discolors spots on stems or leaves, and within two weeks these are usually thickly studded with numerous black specks about the size of a pin point. In these black bodies are contained the spores, which are

FIG. 10.—Black-leg of cabbage, causing the wilting and dying of the lower leaves and a loss of over 75 per cent of the crop in a field.

small and colorless and upon oozing out are distributed by water, wind, insects, and other agencies to healthy leaves and new plants. Wet weather is favorable to the rapid spread of the disease, while the occurrence of maggots or flooding with water increases the liability.

SOFT-ROT.

Description.—Soft-rot of crucifers is characterized by a soft, mushy, almost slimy decay, which after entering, generally at the crown or root tip, spreads rapidly throughout the whole plant. The soft-rot bacteria as a class are marked by their ability to destroy

[1] *Phoma lingam* (Tode) Desmaz.

plants very quickly under favorable temperature conditions. They seldom affect uninjured plants, but require a wound or other injury to gain a foothold. Infection takes place in the field, where considerable damage has been occasioned, but the greatest destruction to this crop is caused in the cabbage storage houses. Under improper storage conditions the disease spreads rapidly, frequently covering all the outer leaves. The slime formed under these conditions is very unsightly and consequently affects the market value, even though only slight injury is caused.

Control.—Fields where the disease is known to occur should be avoided and rotation practiced with crops not injured by soft-rot organisms. It has been found that in storage houses, where the maximum loss occurs, an increase of the temperature much above the freezing point and a high percentage of humidity will result in rapid decay. In view of this fact it is advisable that a temperature uniformly 1 or 2 degrees above freezing should be maintained and the relative humidity kept near that of the outdoor air by careful ventilation. Furthermore, cabbage and other crops when going into storage should be handled carefully, so that they will be injured as little as possible. Since the soft-rot organisms are especially sensitive to light and drying, the crop should be thoroughly dried in the sunshine before being put into storage.

Distribution and loss.—The loss from soft-rot is considerable, especially in storage houses, where 25 to 50 per cent or more of the crop has been destroyed in a single season. The greatest loss occurs in New York and Wisconsin, where the storage of cabbage forms an important industry.

Cause.—Soft-rot in cabbage and related crops is due to bacteria belonging to a group usually referred to as the soft-rot bacteria[1] which may attack carrots, turnips, celery, and other vegetables.

ROOT-ROT (WILT).

Cabbage is frequently grown on rather heavy flat land which is not well drained. Under these circumstances heavy rains may cause surface flooding, especially in any low spots. Where this occurs in midsummer, so that the ground is covered or saturated with water for a few days, especially if followed by hot, sunny days, the fibrous roots are soon drowned or killed from lack of oxygen. Such roots quickly rot, the leaves wilt, and the plants die. It is, of course, important not to confuse the wilting from this cause with similar wilt due to either of the two parasitic diseases already described, clubroot and black-leg.

[1] *Bacillus carotovorus* Jones is a typical example.

MALNUTRITION, A PHYSIOLOGICAL DISEASE.

Malnutrition is a trouble which affects cabbage, cauliflower, and other crops, especially in the Southern States. It is quite different from any of the diseases previously discussed, all of which are caused

FIG. 11.—A cabbage leaf showing the characteristic symptoms of malnutrition. Between the veins the tissue is a light yellow.

by parasites. By malnutrition is meant a disturbance of the normal functions of a plant, which may be a result of its inability to obtain the proper nutrient substances from the soil. Malnutrition may be

caused in several ways, such as the excessive use of mineral fertilizers, the lack of humus, or the accumulation of acids in the soil.

Description.—The most characteristic symptom of malnutrition is a change of the normal green of the leaves to a light green or yellow between the veins and around the margins. (See fig. 11.) The lower leaves are the first to show symptoms; then the upper and inner ones. All diseased leaves are perceptibly thickened and so brittle as to be easily crushed between the fingers.

The heads from plants slightly affected are small and immature; when plants are badly diseased no heads are formed.

The roots are small and the lateral feeders few in number and frequently dead at the extreme end. Often the epidermis of the stem at the surface of the soil is injured, closely resembling the corrosive action of some acids and alkalis.

Control.—In controlling malnutrition, four points need consideration: (1) The limitation of the quantity of fertilizers used; (2) the adjustment of the composition of the fertilizer to meet the crop requirements; (3) the rational use of lime; and (4) the maintenance of the organic matter of the soil.

The practice of farmers tends to increase the quantity of fertilizers when the preceding crop was poor, in the belief that the yield can in this way be maintained. This practice is not always the best. As a result of experiments on early cabbage in Viriginia it was shown that better yields could be obtained from 1,000 pounds per acre of mineral fertilizer than from any larger quantity up to 4,500 pounds, which gave the smallest yield of all.

The composition of the fertilizer or the ratio of the different substances composing it should be such as to give an alkaline rather than an acid reaction, for acid soils have been found to increase and alkaline soils to decrease the severity of the malady. As malnutrition is worst on acid soils, air-slaked lime at the rate of 1,000 to 2,000 pounds per acre should be added. Among the more important effects of liming soil the following may be mentioned: (1) To render available certain forms of plant food, especially compounds containing potassium; (2) to facilitate the decomposition of organic matter by encouraging the growth of microorganisms; (3) to promote the growth of organisms that gather nitrogen from the air; and (4) to improve the physical texture of the soil.

Many of the old cultivated fields of the South are ordinarily deficient in humus or organic matter, a condition for which mineral fertilizers are largely responsible.

Humus can be supplied to such a soil by the use of stable manure or by growing green-manure crops, such as cowpeas, soy beans, vetches, etc., to be turned under when mature. The results from this

method of restoring natural fertility to the soil are ordinarily very marked on the first succeeding crop.

Distribution and loss.—Malnutrition diseases are confined principally to those localities where mineral fertilizers are used in order to produce larger and earlier crops. The disease, therefore, is restricted mostly to the Southern States. In general these soils are poor, respond quickly to fertilizers, and have been intensively and carelessly farmed for many years. The loss from this trouble, though large, can not be accurately estimated.

Cause.—Constant, clean cultivation for many years has robbed the soil of most of its original fertility. The farmers, therefore, naturally turned to the use of commercial fertilizers as a substitute. The results for many years were very gratifying. At the outset better crops were obtained than was possible on the best soils without fertilizers. This led the farmers to believe that fertilizers alone were necessary on any soil and the more used the greater the yield. When the returns decreased as a result of this practice the quantity applied was gradually increased until it was not uncommon to add as much as 3,000 pounds of mineral fertilizers per acre for a single crop of cabbage. A large part of the fertilizer applied was not used by the plants, but remained in the soil, where in the course of a number of years a considerable quantity accumulated.

It is a well-known fact that the salts comprising mineral fertilizers are poisonous to plants when used in excessive quantities. Some fertilizers have an acid reaction and eventually cause what is popularly known as "sour soil." On the other hand, a small quantity of acid in the soil is not generally injurious, but it is not uncommon to find soil in the South so acid as to require 5,000 to 9,000 or more pounds of lime per acre to neutralize it. No agricultural plants will give their best yield under such conditions.

Briefly summarized, malnutrition in truck crops is caused by the excessive use of mineral fertilizers and the exhaustion of the humus of the soil.

DOWNY MILDEW.

Description.—Downy mildew first appears in the spring as a whitish mold in isolated spots on the undersides of the leaves. It may also occur on the stems. At the close of the season the portion of the leaf immediately surrounding the diseased area appears yellow and later turns brown and dries up. Frequently, light areas are observed in the center of a dark ring, which in turn is surrounded by a light or yellow area, thus presenting a conspicuous mottled appearance.

Control.—Downy mildew is seldom so troublesome as to require remedial measures. It is likely that most cruciferous weeds are attacked by this organism. Such weeds are sources of infection to cabbage and related crops and should be kept down. Any plants found diseased in the seed bed should be destroyed, not planted. The remains from diseased plants should be destroyed, as they serve to carry the resting spores over the winter. Crop rotation should be practiced. The plants should not be grown too thick or kept too wet in the seed bed. If, in spite of such precautions, the mildew is

serious, the plants in the seed bed should be sprayed about once a week with Bordeaux mixture (4–4–50 formula).[1]

Distribution and loss.—Downy mildew seldom causes any serious loss except in seed beds. It has been found in Australia and Europe and has been reported from several States in the United States. It undoubtedly occurs wherever cabbage is grown, but owing to the fact that it causes but little loss to the crops it has not been reported.

Cause.—Downy mildew[2] attacks all crucifers and causes distortions and abnormal growth. Two forms of reproductive bodies are produced. In one of these spores are developed in the air on the surface of the host, forming a visible down coating. When these spores germinate, the germ tube enters the tissue of the host and a new infection is started. These reproductive bodies are formed in great numbers and are readily carried from one plant to another by a gentle breeze or by insects. The disease is carried through the winter by means of yellowish, thick-walled bodies which are able to withstand unfavorable conditions until spring, when they germinate and reestablish the disease.

WHITE-RUST.

Young plants are more subject to attack, but the damage to cruciferous crops from white-rust is ordinarily very slight. The disease may occur on any part of the plant above ground, but more frequently on the leaves, where the tissue is often stimulated to distorted and abnormal growth. Moist, cloudy weather furnishes suitable conditions for the spread and growth of this disease.

Control.—Control measures are rarely necessary; if required, spray the plants in the seed bed once each week with Bordeaux mixture (4–4–50 formula[1]). The seed bed should not be kept too moist. Set only healthy plants in the fields and destroy all others.

Distribution.—White-rust is distributed throughout the world and is found on all crucifers. Apparently, however, it does not spread from the common wild mustards of America or from radish to cabbage. This indicates that there are specialized races or forms of the parasite and may account for the fact that the disease is not found as widespread on cabbage as on most other related plants.

Cause.—The disease is caused by a fungus[3] which enters the tissue of the host through the stomata, or breathing pores. Small oval spores are formed, which are attached one to another in a beadlike manner under the surface. They finally escape and are then easily wafted by the wind or carried on the body of insects to other plants. In the presence of sufficient moisture and at low temperatures they readily germinate, and the fungus enters the stomata, or breathing pores, if lodged on the proper host. The disease is carried through the winter by the formation of bodies within the tissue of the host, from which they are set free the following spring by the decay of the plant.

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[1] This formula is 4 pounds of copper sulphate (blue vitriol) and 4 pounds of stone lime to 50 gallons of water.

[2] *Peronospora parasitica* (Pers.) De By.

[3] *Albugo candida* (Pers.) Ktz.

DROP.

Description.—The earliest symptoms of the disease known as drop are indicated by water-soaked areas over the stem and lower leaves. This wilting of the lower leaves is followed by the whole plant collapsing finally into a shapeless mass. The plant may succumb to the disease in a few days, or it may live from one to two or more weeks. In and about the decayed region a dense, white, cottony mass of mycelium accumulates. In the later stages of the disease irregularly shaped, hard, black bodies, about the size of a mustard seed, are to be found scattered among this cottony mass. These bodies are almost sure evidence of the disease.

Control.—This fungus is best known as the cause of the lettuce drop. It also causes a serious disease of the cucumber, carrot, and potato, of various bulbs, and of other plants. In view of this fact, care should be taken in the rotation not to follow lettuce with cabbage on fields where the drop has occurred. It is further advisable, when possible, to pull up and destroy infected plants. Compost which may contain the refuse of lettuce, cabbage, and other crops that have been destroyed by the fungus should not be used on cabbage beds or in the field.

Distribution and loss.—The cabbage drop is worst along the Gulf coast region. During some seasons the disease causes heavy losses to the crop in southern Alabama and parts of Florida and Texas. Though its distribution has not been thoroughly studied, it is likely that the disease occurs in other States as well.

Cause.—The drop is caused by a fungus[1] made up of a coarse, white, fungous growth which forms in and about the decayed region of the host. Later the hard, black bodies mentioned above develop from the mycelium.

SPOT DISEASE OF CAULIFLOWER.

The spot disease was first found to attack the leaves of cauliflower, but later was observed on cabbage to a more limited extent. It causes on the lower surface of the leaf, and less abundantly on the upper, small brownish to purplish gray spots (fig. 12) somewhat irregular in outline. A puckering of the leaf results when the midrib and larger veins are badly affected.

Some loss was caused to cauliflower in tidewater Virginia during the spring of 1911, where 25 to 90 per cent of the plants in the worst cases were attacked.

This is a new disease of cauliflower and cabbage, due to a bacterium, and no means for its control have been worked out. It has been observed that the spot disease is most severe during cool, damp weather, and is held in check when the warm, sunny days of late spring come on. In view of the fact that the organism is especially

[1] *Sclerotinia libertiana* Fuckel.

sensitive to sunshine and warm weather, it is not likely to cause any serious damage except during protracted rainy, cool weather. Crop rotation should be employed in controlling it. So far as known, the organism causing the spot disease of cauliflower and cabbage does not attack any other crucifers.

FIG. 12.—Upper surface of a cauliflower leaf, showing typical injury caused by the spot-disease organism.

BLACK LEAF-SPOT (BLACK MOLD).

Description.—The black leaf-spot fungus may attack the cabbage plant at any stage of its growth, but is not common except on the older leaves in the field or on heads in storage. In the field it appears on the lower or outer leaves of the maturing plants as distinct, roundish, black spots, commonly marked with concentric brown zones (fig. 13). These spots vary from one-fourth to one-half an inch or more in diameter. In storage these spots may blend together until the outer leaves are covered and entirely blackened by the moldy development.

Control.—To prevent loss from this fungus in the storage house the following suggestions should be observed: (1) Disinfect the storage house by spraying the walls, benches, and bins with Bordeaux mixture; (2) exercise care in handling, so as to minimize injury to the heads; (3) maintain a temperature 1 or 2 degrees above freezing; and (4) keep the humidity as low as possible by proper ventilation of the house with outside air.

Distribution and loss.—Black leaf-spot causes considerable damage to cabbage and collards in this country and in Europe. The greatest loss to cabbage occurs in the storage houses. The organism causing the disease is present in the houses under ordinary conditions, or it may be carried there with the cabbage when it goes into storage. It gains access to the tissue through wounds made by handling and cutting or by following up the tissue killed by other organisms. In the presence of plenty of moisture and a suitable temperature it develops rapidly, forming an unsightly black mold over the heads.

Cause.—The commonest form of black leaf-spot is due to a fungus,[1] but other related fungi may cause similar leaf spotting and other fungi contribute to the molding in storage.

POWDERY MILDEW.

Powdery mildew is caused by a parasitic fungus[2] which forms a white powdery dust on the leaves of turnips, cabbage, and a few other plants. The loss caused by this disease is so slight that treatment is unnecessary.

DAMPING-OFF.

Damping-off is a disease of young seedlings and may be caused by any one of several species of fungi. It occurs mostly in the seed bed, where plants are growing in a crowded condition. It is rarely found in the open field. It is also a common disease in greenhouses, where a relatively high humidity is maintained and where the plants are protected from sunshine and free circulation of the air. The disease usually attacks the seedling on the stem at the surface of the soil soon after it comes through the ground. It soon girdles the stem and destroys the epidermis. The plant finally topples over and dies.

FIG. 13.—Black leaf-spot of cabbage; characterized by concentric rings.

Preventive rather than curative measures should be employed for this disease. Since it may result from spores carried on the seed, it is best to disinfect the seed (p. —) as a general precaution.

If damping-off has occurred before, the soil should not be used again, or if used should be sterilized in accordance with one of the methods already discussed. Any method that will prevent the accumulation of too much moisture in the surface soil and reduce the relative humidity of the air about the plants is advantageous in preventing damping-off. This can be accomplished by practicing the following suggestions: (1) The upper layer of soil should be frequently stirred; (2) a free circulation of air about the plants and exposure to sunshine should be permitted; (3) the plants should be watered in the morning in preference to the late afternoon or evening; and (4) a layer of fine, heated sand should be sprinkled over the surface of the soil.

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[1] *Alternaria brassicae* (Berk.) Sacc. [2] *Erysiphe polygoni* DC.

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